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ABSTRACT

This manual serves as an energy conservation reference and management guide for school districts. The School District Energy Program (SDEP) is designed to provide information and/or assistance to school administrators planning to implement a comprehensive energy management program. The manual consists of 15 parts. Part 1 describes the SDEP; Parts 2 through 14 contain information that address different aspects of School District Energy Conservation: (1) Conservation Guidelines; (2) The Role of Administration; (3) Data Collection for Energy Conservation; (4) Energy Management Systems; (5) Operations and Maintenance for Energy Conservation; (6) Heating, Ventilation, and Air Conditioning (HVAC) Controls; (7) The Custodian and Energy Conservation; (8) Preventive Maintenance; (9) Role of the Teacher; (10) Transportation Energy Conservation; (11) Public Utilities: Demand Side Management; (12) Building Life Cycle Cost; (13) In-house Incentives Program; and (14) Available Resources. Part 15 includes a glossary of commonly used energy terms and four appendices which describe data collection; operations and maintenance audits; transportation energy conservation checklist; and performance contracting. (JM)

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School District Energy Manual

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PROLOGUE

This manual was produced as an energy conservation reference and management guide for school districts. A project of the New Jersey Association of School Business Officials (NJASBO), the School District Energy Program (SDEP) is designed to provide information and/or assistance to school districts planning to implement a comprehensive energy management program. School business officials have been collecting, sharing and modifying energy conservation forms and procedures for several years. The manual attempts to bring together, in a usable format, some of the wealth of practical suggestions and experience found in the field.

The manual consists of 15 parts. Part I describes the SDEP; Parts II through XV contain information that addresses different aspects of School District Energy Conservation. Four functional appendices complete the document.

This manual should be used only as an energy management guide. Suggested forms and procedures should be modified, if needed, to supplement or implement a specific part, or parts, of a local district energy conservation program.

Energy conservation is an on-going process. Changes constantly take place in model building regulations for the protection of public health, safety and welfare. Low-tech and high-tech conservation options are offered by education architects. New methods of building and new materials especially geared to reduce energy loads arrive on the scene with regularity.

In addition to using this publication as a guide, districts should be certain to ensure that energy conservation programs conform to current regulations—especially in health and safety areas.

Information regarding requirements for BOCA or state codes, current health and safety regulations, or changes in legal aspects of energy conservation contracts, can be obtained by contacting local agencies.

ACKNOWLEDGMENTS

The New Jersey Association of School Business Officials is deeply appreciative of the multitude of assistance received from various quarters that made production of the *School District Energy Program Manual* possible. Initial thanks must go to the NJASBO Facilities Committee for the fine job these dedicated individuals did drafting the document.

Extreme gratitude is extended for the commitment of time, expertise and financial contributions received from New Jersey's Utility Companies.

Also, NJASBO members forward their personal thanks to Dr. Wallace Piper, former executive director of Michigan ASBO, and his constituents for developing and sharing the MASBO Total School Energy Manual with out-of-state colleagues.

In closing, it is the belief of all the dedicated individuals and organizations who helped make this document a reality that the *School District Energy Manual*, if properly utilized, can be the catalyst needed to conserve energy and save money for school districts.

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INTRODUCTION

THE SCHOOL DISTRICT ENERGY PROGRAM (SDEP)

The School District Energy Program (SDEP) is designed to provide information and/or assistance to school administrators interested in implementing comprehensive energy management programs tailored to meet the particular needs of their districts.

The basic goals of the program are as follows:
1. To enhance awareness of the cost of wasting energy and present possible solutions.
2. To encourage the use of energy management tools.
3. To bring about a reduction in energy usage and energy costs for participating districts.

The basic objectives of the program are as follows:
1. To develop an energy management program within participating school districts that will identify school energy users and meet identified needs.
2. To produce a 10 to 30 percent reduction in energy use within participating school district facilities through management commitment, planning and use of specific operation and maintenance procedures.
3. To assist participating districts in developing a building-level energy database by recording information on types and amounts of energy used, identifying energy sources and problems, and developing expertise to deal with the energy information needs of schools.

SDEP SERVICES SUGGESTED—PHASE I

ENERGY PLANNING SEMINAR

As the first step in the program, an Energy Planning Seminar should be run. In the Energy Planning Seminar, an energy management consultant should be obtained to meet with a team of school officials including, but not limited to, the Superintendent, the Business Administrator, the Supervisor of Buildings and Grounds, the Transportation Director and the Director of Curriculum.

The task of the Energy Planning Seminar participants will be to develop a one-year energy plan for their district. With the guidance of the consultant, the group should review the district's current policies, practices, and procedures in energy conservation and decide in which areas the district needs help. The consultant will outline various offerings available for a SDEP and the group will decide in which ones the district would participate (see SDEP Diagram page 5).

The basic objectives of the seminar are as follows:
1. To review energy conservation policies, procedures and practices of the district
2. To review data collection procedures
3. to discuss appropriate energy saving options and energy conservation activities for the district
4. To develop a district-specific Energy Management Plan that includes:
   a. Recommendations on energy-related policies.
   b. Recommendations on energy data collection procedures.
   c. A sampling of energy conservation activities that the district may implement in the following year.
   d. A directory of utilities and other sources offering assistance to school districts.
   e. Identification of key personnel responsible for ensuring that the plan is implemented.
   f. A preliminary energy audit (done with the assistance of an energy consultant) for all school buildings in the district.

Preparation and submittal of the district's Total School Energy Plan (a district-specific, one-year plan and a projected five-year plan) by project staff would complete Phase I of the SDEP program.

SDEP SERVICES SUGGESTED—PHASE II

In Phase II, SDEP consultants obtained by the district would provide support, information and/or training in areas described below. Each of the programs could involve between three and four hours of on-site consultant time.

DATA COLLECTION SEMINAR

Accurate and timely energy consumption data is essential in setting up and monitoring an energy conservation program. If a district does not know how much energy is being used, energy savings cannot be accurately evaluated. In this seminar, SDEP consultants would:

1. Review the district's current data collection and information dissemination procedures.
2. Review for consideration an energy data model that has been successful in another district.
3. Discuss implementation of that model to meet the district's specific needs.

OPERATIONS AND MAINTENANCE SEMINAR

Actual savings in BTUs is dependent on *efficient operation* of the building and *effective maintenance* of energy-using equipment. Every energy conservation program must have a trained and energy-conscious maintenance/custodial staff. This seminar provides an opportunity for a district's maintenance staff to receive individualized training in walk-through auditing.

Walk-through auditing is the ability to look at the building and identify the energy users, assess their current level of efficiency and make recommendations for increased efficiency. In the Operations and Maintenance Seminar, the SDEP consultant would walk through a building with a small group of the district's personnel, pointing out what they should be looking for when auditing a building for efficient energy use, as well as making specific recommendations for change in the building being audited. After the seminar, district personnel would be better prepared to audit the remainder of the district's buildings.

PREVENTIVE MAINTENANCE WORKSHOP

Maintaining equipment so it operates at peak efficiency is important in an energy conservation program. This workshop will provide key maintenance staff with an overview of preventive maintenance covering the following areas:

1. Purpose and commitment to preventive maintenance.
2. Inventory techniques for mechanical, electrical and structural items.
3. Maintenance procedures for major equipment.
4. Suggested preventive maintenance tasks.
5. Scheduling major equipment maintenance.
6. The work order system and estimated hours for each maintenance task.
7. Effective use of contractors.

At the conclusion of this program, the school should have enough understanding of preventive maintenance and its requirements to determine if the district has enough expertise, financial support, and staff to implement such a program.

CUSTODIAL SEMINAR

This program is designed as an awareness program for custodians. Custodians are important in maintaining an on-going energy conservation effort in a building. This half-day seminar would provide the custodial staff with practical day-to-day operational and maintenance procedures that can save energy. A comprehensive custodial checklist (including daily, weekly, monthly, and seasonal check points) has been developed for use in the Custodial Seminar. A second half-day seminar would provide custodians/boiler operators with boiler room and related equipment operating procedures.

ADMINISTRATIVE SEMINAR

This program introduces first-line administrators to their role in energy conservation. Principals provide leadership at the building level. They need to understand and support the energy conservation program if it is to be successful. This seminar would discuss how the rising cost of energy affects the district, the administrators, the teachers and students.

If all administrators are involved in the planning and implementation stages of an energy program, there is a much greater chance for its on-going success. The objectives of the administrator program are: (1) to create an awareness of the need for commitment to energy conservation, and (2) to understand the potential for savings through energy conservation.

TRANSPORTATION ENERGY CONSERVATION SEMINAR

A school district's transportation fleet is often its most visible support operation. Consequently, a strong conservation program in transportation can be one of the district's most valuable conservation efforts, especially from a public relations perspective.

A suitable program would assist school transportation managers in developing and maintaining an effective energy management plan that will lead to reduced fuel consumption levels in their transportation fleet.

The transportation program should include a discussion of:

1. Policies for energy conservation in transportation programming and scheduling.
2. Record keeping for energy conservation in the transportation fleet.
3. Quick-fix energy conservation techniques in transportation of scheduling, driving practices and vehicle maintenance.
4. Planning for possible fuel shortages.
5. Possible use of alternative fuels in the transportation fleet.

PREVENTIVE MAINTENANCE PROGRAM (PM)

This four-part program provides training for key district maintenance staff needed to set up a preventive maintenance program. Suggested sessions in this program are as follows:

1. *Inventory techniques for mechanical, electrical and structural items*—instruction in use of an inventory form; discussion of a master equipment file for the district.
2. *Maintenance functions*—the consultant should meet with district personnel and maintenance personnel to discuss maintenance procedures for mechanical, electrical and structural items. Personnel would be instructed in field inspection and maintenance procedures for district equipment.
3. *Scheduling function*—the consultant would meet with district personnel to begin the district's scheduling frequencies of mechanical, electrical and structural items.
4. *Work order system*—district personnel would work with the consultant to plan the work order system needed to implement the district's PM program.

ENERGY MANAGEMENT SYSTEMS ANALYSIS

This seminar is designed for those districts interested in installing an energy management system. The program is designed to evaluate the following areas:

1. Need for an energy management system.
2. How the energy management system can help the district.
3. Points to consider in the purchase of an energy management system.
4. Initial training needs and data required for an energy management system.
5. Advantages and pitfalls of an energy management system.
6. The type of energy management system most feasible for the district's needs.

This program should be presented to the district's energy conservation team, which would include an administrator, a board member, a maintenance supervisor and any other school personnel involved in facility or data management.

BUILDING SYSTEMS ANALYSIS

In this program, a SDEP consultant and the district's director of operations, or a representative, would walk through a building within a district that has been identified as having a problem with energy conservation management. The consultant would analyze the basic operations within that building, observe how the building's systems actually operate and make recommendations for more efficient energy conservation management. This may be achieved either by procedural change, system modification, or actual system change, if deemed necessary. The district should receive a written report of these recommendations. It should be noted that all system changes to the building must be made in accordance with applicable codes and be submitted to the state department of education for approval.

BOILER EFFICIENCY WORKSHOP

This should be a "hands-on" experience, invaluable to those concerned with the efficient operation and maintenance of boilers. It includes actual testing of an operating boiler as well as informational presentations on the fundamentals of characteristics, discussion of various boiler types and principles of combustion and efficiency. Topics for this workshop should include:

1. Energy conservation and boiler efficiency improvement
2. Combustion fundamentals
3. Understanding boilers and burners
4. Efficiency improvement methods
5. Combustion testing and combustion test instruments
6. Boiler combustion efficiency testing

At the conclusion of the workshop, participants should better understand the principles of boiler efficiency, its importance in an ongoing energy conservation program, and be able to test and calculate combustion efficiency.

TEACHERS IN-SERVICE

This program should be designed to stress the importance of teacher participation in the total energy conservation effort. Teachers account for approximately 60 percent of the school staff and have more contact and impact with the students than any other school personnel. Teachers are the trainers of our future adults and can be very instrumental in the development of conserving energy resources for everyone's future. Teacher in-service can provide the opportunity for a significant impact within the district's community energy conservation programs and goals. The objective of such a program would be to provide an awareness of how classroom energy control by the teacher can impact the total energy effort.

The program should include the following topics:

1. The impact of rising utility costs and how these reflect on budgeted items such as salaries and materials.
2. The teacher's role in energy conservation.
3. What teachers can do to lower energy consumption at the classroom level.
4. Explanation and provision of samples of curriculum programs that can be implemented.

SCHOOL BOARD WORKSHOP

In this workshop, school board members would learn how rising costs of energy affect the school district and community. The importance of adopting and supporting a comprehensive energy conservation policy specific to the needs of the district, and the community, should be stressed. The importance of active, district-wide and building specific energy conservation committees should be emphasized. School board members are faced with numerous policy and financial decisions, many of which are directly or indirectly related to energy costs and usage and community attitudes toward both. This workshop would provide board members with ideas and insights on how to identify, weigh and balance those decisions.

STEAM TRAP PROGRAM

This seminar would provide instruction on steam trap operation and maintenance. It would meet a need observed within many school districts.

The program would cover the following materials:

1. Purposes of steam traps
2. Types of steam traps
3. General overview of condensate systems
4. How to start a steam trap maintenance program

CONTROLS MAINTENANCE CONTRACT WORKSHOP

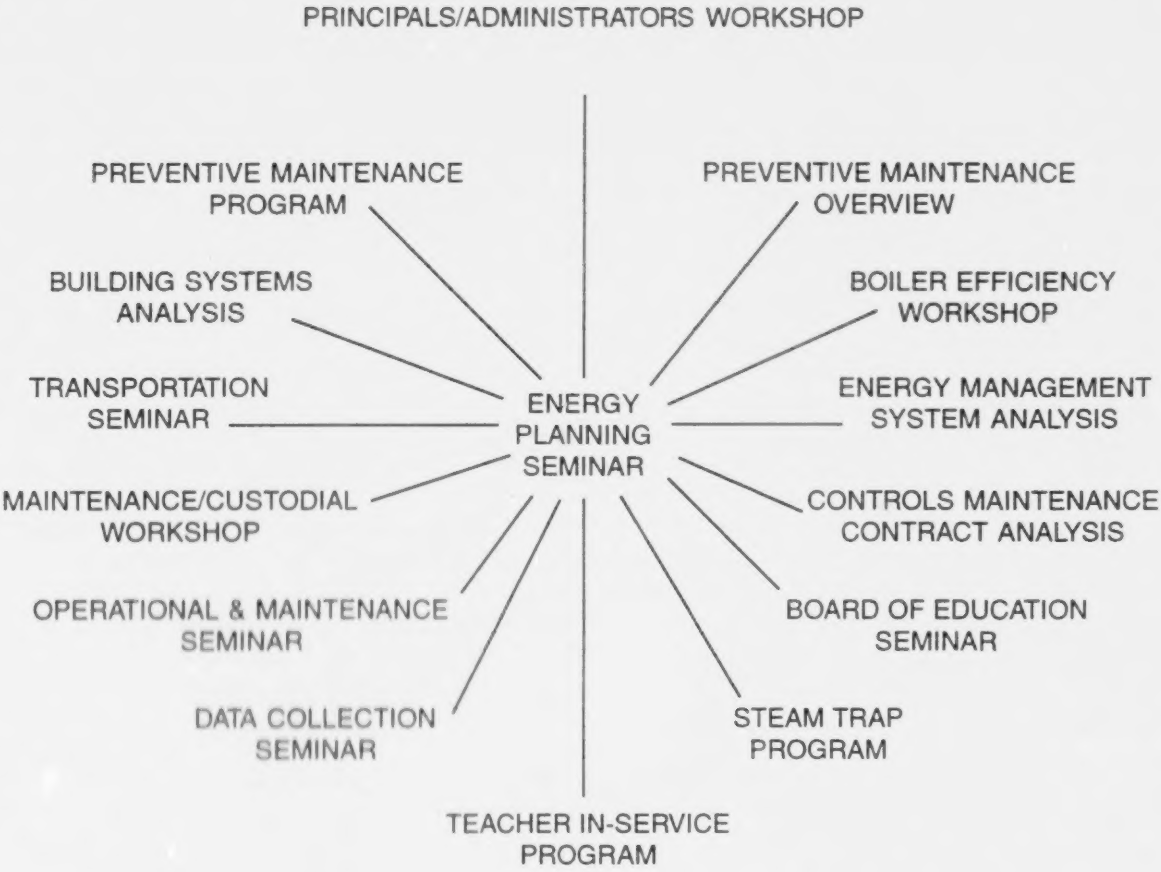
This recommended in-service workshop is designed to review and evaluate controls maintenance contracts for HVAC and pneumatics in a building or a district. A key component is review by the consultant, with key maintenance personnel, of basic guidelines to be considered in contracting for these services. It also would include a walk through of a building's mechanical system and identification of major systems and controls. Assistance would be available at this time for development of an equipment inventory of HVAC and pneumatic controls, a vital component in the establishment of an encompassing service contract.

SDEP SERVICES SUGGESTED—PHASE III

FOLLOW-UP CONSULTATION

After a participating district has sought and received SDEP services and has begun to implement the comprehensive energy plan designed during the Energy Planning Seminar, a SDEP energy management consultant should be obtained to schedule a follow-up visit with the key energy users in the district. At the follow-up session, the group would review progress and discuss any problems that had arisen during the implementation of the plan. The group and the consultant would evaluate the plan, and the district's efforts, and modify the plan, if needed. In so doing, the district may identify other programs for increasing or maintaining its energy conservation thrust.

SCHOOL DISTRICT ENERGY PROGRAM


PRINCIPALS/ADMINISTRATORS WORKSHOP
PREVENTIVE MAINTENANCE PROGRAM
PREVENTIVE MAINTENANCE OVERVIEW
BUILDING SYSTEMS ANALYSIS
BOILER EFFICIENCY WORKSHOP
TRANSPORTATION SEMINAR
ENERGY PLANNING SEMINAR
ENERGY MANAGEMENT SYSTEM ANALYSIS
MAINTENANCE/CUSTODIAL WORKSHOP
CONTROLS MAINTENANCE CONTRACT ANALYSIS
OPERATIONAL & MAINTENANCE SEMINAR
BOARD OF EDUCATION SEMINAR
DATA COLLECTION SEMINAR
STEAM TRAP PROGRAM
TEACHER IN-SERVICE PROGRAM

PART I—CONSERVATION GUIDELINES

RECOMMENDED POLICY GUIDELINES

This section includes the SDEP's recommended policy guidelines in the areas of:

1. Heating/cooling temperatures
2. Domestic hot water temperatures
3. Ventilation levels
4. Lighting levels
5. Per-building total energy consumption

The levels recommended in this section have been successfully implemented by numerous school districts and have been found to provide an acceptable environment while decreasing energy consumption. The SDEP recommends that these, or similar guidelines, be included in a school district's energy conservation policy and procedures. This ensures a clear understanding of the district's commitment to energy conservation and provides everyone involved with objective criteria by which to measure and enforce conservation. For example, a clear policy on temperature levels notifies both teachers and custodians of expected classroom temperatures leading to increased accountability and decreased controversy.

HEATING/COOLING TEMPERATURES

Below is a table showing some recommended temperatures for interior space. The levels have been used successfully in many school districts.

Type of Space	Recommended Heating Level		Recommended Cooling Level	
	Occupied	Unoccupied	Occupied	Unoccupied
Classrooms—high school & middle school	68°	55°*	78°	off
Classrooms—elementary	65-68°	55°*	78°	off
Unoccupied & Storage Areas***	55°	55°*	off	off
Pool areas	78-82°**	**	off	off

* *Caution: Be sure to maintain a temperature level that will prevent pipes from freezing.*

** *At least 2° above water temperature.*

*** *Corridors and lobby would be reduced.*

ILLUMINATION LEVELS

		Recommended Standard
Auditorium:	Assemblies; Stage/Exhibition; Social Activities	10–50 FC
Cafeteria:		20–50 FC
Classrooms:	General Use; Demonstration Area; Assemblies	30–50 FC*
Gymnasium:	General Exercise; Exhibition/Matches	20–30 FC
	Assemblies	60 FC**
Libraries:		30–60 FC
Offices:		30–50 FC
Services:	Store Rooms	10 FC
	Toilets/Washrooms; Locker Rooms	10–30 FC
Vocational Ed:* **	Shops	30–50 FC
Drafting; Typing		40–60 FC

*75 FC for children with limited vision.
**Special lighting for sports contests only.
***Task lighting should be used for visually difficult work.

DOMESTIC HOT WATER TEMPERATURES

Use	Recommended Temperature Level	
	Occupied	Unoccupied
Personal	105°	off
Kitchen	*Maintain state and local health department requirements for wash, rinse and sanitization requirements (usually 160° wash, 180°)	off

**Contact your local health department for information.*

Restrict water flow from non metered lavatory faucets to 0.5 gallons per minute (GPM) (private = 2.2 GPM) and from showers to 2.5 GPM.

Metered lavatory faucets: 0.25 gallons/use.

VENTILATION LEVELS

Ventilation levels should be reduced as far as possible—consistent with health standards. Ventilation levels should normally not be reduced below the original design. Code requires 15 cubic feet per minute (cfm) per student, and businesses use 20 cfm per person. Health department standards may also be obtained by contacting the your local health department. During the heating season, no area (except special areas such as pools, boiler and mechanical rooms, rooms with caustic chemicals, etc.) should be ventilated when unoccupied.

LIGHTING LEVELS

The chart above presents recommended lighting levels in footcandles. Footcandles should be measured at the task or work level.

The higher level may be necessary in some areas in a room (i.e., near the blackboard) while in others, the lower end of the range will be adequate.

GENERAL STANDARDS OF ENERGY CONSUMPTION

Annual energy consumption per square foot varies from building to building depending on operating practices, weather, HVAC system type, building construction and occupancy hours. It is possible to classify schools by

HVAC system type and to establish general standards for energy consumption.

HVAC system types (and building floor plans and construction as well) have changed slowly over the years; buildings built within the same period are normally quite similar. School buildings can be separated into four general groups by HVAC system type:

> *Steam heat/limited cooling* buildings include typical two-floor pre-WW II buildings and post-WW II buildings (generally one floor) constructed before 1954. This group (after customary renovations) has primarily fluorescent lighting with barely adequate light levels, modest air-handling electric motor consumption for unit ventilators, a few exhaust fans and very low AC consumption for a few window units or an office.
>
> About 1954, school heating plant designs switched to hot water heat, but cooling was still limited to office areas. We will call this group *hot water/limited cooling*. Heating fuel consumption for this group is up in part because of higher ventilation rates, and, more importantly, because increased HVAC control system complexity and the freeze protection requirements of hot water systems resulted in higher heating input during unoccupied periods. Electric consumption increased substantially due to heating hot water pumps and the somewhat higher fan and lighting load. Even today many new schools can be placed in this group, especially where a tight budget for construction kept the building arrangement simple and limited AC services to office areas.
>
> By the late 1930s more complex school buildings became the vogue—especially high schools. Architects chose to ignore the customary center corridor floor plan in favor of larger interior areas requiring extensive AC systems that were often rooftop HVAC units. In many of these schools, the traditional boiler rooms were replaced with gas-fired furnaces within the rooftop units. During this period, even for schools with more traditional floor plans and traditional boiler-based heating systems, AC coverage was often extended from office areas to libraries, cafeterias, and even to the entire building. Lighting levels were also considerably higher in many of these buildings. These buildings are called *complex/extensive cooling* in the table on page 10.
>
> In the late sixties until about 1978, a large number of *all-electric buildings* were constructed. This all-electric group varies widely in consumption. The all-electric concept includes simple buildings where the all-electric design was chosen because of low construction costs, and complex buildings with extensive cooling where the all-electric concept was oversold by the utility companies. A further substantial variation in energy consumption for this group resulted from the wide difference between the performance between electric resistance heat and the more efficient electric heat pump.

ENERGY CONSUMPTION STANDARDS

The table on page 10 shows annual consumption per square foot for heating fuel and electricity for "typical" and "closely controlled" schools. "Closely controlled" means that, through careful adjustment of a time clock controlled HVAC control system, or through a well-designed and carefully monitored and programmed energy management system, building temperature and ventilation levels closely match occupancy schedules. Morning warmup and night setback are fine-tuned. "Typical" values are what one expects to find in an average northeast school where energy management has been given only occasional attention.

Results are based on data files compiled in more than 400 schools in one state over the past 15 years. The values shown are for elementary schools. For high schools, add the percentages shown to the elementary values to allow for the extended operating hours typical of most high schools.

The figures listed are for a standard lighting plant (primarily fluorescent lighting) using energy efficient lamps in standard ballasts.

ENERGY AWARENESS CHECKLIST

The list below contains some major energy conservation techniques suggested for implementation by school districts concerned with saving energy and energy dollars. The list is not intended to be exhaustive, but does include many energy saving recommendations.

SCHOOLS IN THE NORTHEAST HAVE DEMONSTRATED THE FOLLOWING ENERGY CONSUMPTION

	Typical		Closely Controlled	
Group	Heating BTUs Per Year Per SF	Electricity KWH Per Year Per SF	Heating BTUs Per Year Per SF	Electricity KWH Per Year Per SF
Steam Heat/ Limited Cooling	72,000 (HS+10%)	4.1 (HS+25%)	54,000 (HS+10%)	3.9 (HS+25%)
Hot Water Heat/ Limited Cooling	80,000 (HS+10%)	4.6 (HS+25%)	60,000 (HS+10%)	4.4 (HS+10%)
Complex/Extensive Limited Cooling	76,000 (HS+10%)	6.2 (HS+25%)	57,000 (HS+10%)	5.8 (HS+25%)
All-Electric	NA	17.0 (HS+25%)	12.5	(HS+25%)

LIGHTING

1. Reduce lighting to recommended levels (see SDEP illumination levels, page 8).
2. Eliminate decorative and display case lighting.
3. Reset outside light timers periodically to minimize use.
4. Use brightly colored light switch stickers to remind people to turn out the lights when leaving rooms.
5. Instruct teachers to use task lighting when possible.
6. Instruct custodians to use lights only in rooms being cleaned. Schedule daylight cleaning when possible.
7. Use multiple switching to allow selection of various light levels.
8. Label multiple light switches to indicate which lights they operate.
9. Install twist timers on lights in problem areas, such as restrooms, shower areas, lounges and storage areas.
10. Reduce incandescent light wattage or replace with fluorescent lights.
11. Replace fluorescent lamps on a regular basis, i.e., after 80 percent of lamp life is used. (Fluorescent lamps use more energy and produce less light during the last 20 percent of lamp life.)
12. Disconnect ballasts from fixtures which have the bulbs removed. They use a small amount of energy and will burn up if not disconnected.
13. Keep light fixtures clean; replace yellowed lenses.

WINTER SEASON: HEATING AND VENTILATION

1. Set thermostats at recommended levels, 65° to 68° for winter (kindergarten and special education rooms, 70° to 72°) or at temperatures set by administrative guidelines or board policy.
2. Reduce temperature in gyms, shops, restrooms. Experiment with shutting off heat in corridors, lobbies and vestibules but not to the extent that water lines freeze.
3. Maintain storage rooms and unoccupied spaces at 50° to 55°, but prevent freezing water lines.
4. Reduce heating in garages and docks to the lowest level possible without freeze-up.
5. Set night setback temperature at least 10° below daytime temperature.
6. Activate night setback control cycle as early in the day as possible.
7. Set all time clocks to obtain minimum equipment operating times.
8. Upgrade inoperative control systems.
9. Consider shutting down heating plant during unoccupied hours and during mild weather.
10. Close fresh air intake dampers on ventilation fans when building is on the warm-up cycle and fans are off.
11. Try starting ventilation fans later than usual and shutting them off earlier than usual.

12. Experiment with shutting off exhaust fans; check that back draft dampers close tightly.
13. Position wall hangings, displays and furniture away from supply and return air grilles and registers to prevent obstruction of air flow.
14. Use windows for ventilation in mild weather; shut off ventilation fans.
15. Establish a maintenance program for the HVAC system that includes the following:
    a. Repair or replace leaking steam traps and control valves
    b. Repair leaks in heating pipes
    c. Repair or replace heating system piping insulation
    d. Clean boiler combustion chamber
    e. Clean scale from waterside of boiler surfaces
    f. Clean boiler room combustion air intake;
    g. Clean and/or replace air filter's in unit vents and air handling systems
    h. Clean fin tube radiation
    i. Clean air grilles and registers
16. Establish operating and maintenance plans for the central boiler, chiller and distribution systems.

SUMMER SEASON: COOLING/VENTILATION

1. Operate air conditioning units only when absolutely necessary.
2. Set cooling thermostat setting at 78°F or at established guidelines.
3. Do not cool unoccupied spaces.
4. Use outside air for cooling on cool days instead of operating the air conditioning system.
5. On cool nights operate fan systems periodically at 100 percent outside air to cool non-air conditioned buildings.
6. Install ambient air temperature controls on air conditioning system to lock out compressor operation when outside air temperature drops below a predetermined temperature.
7. Shut off air handling units and lights in gyms when physical education classes are outside in warm weather.
8. Turn off non-critical exhaust fans. Be certain these fans are not interlocked with other air handling units or are utilized to maintain system balance. Codes should also be consulted prior to de-energizing "noncritical exhaust fans."
9. Reduce internal heat gain as much as possible by turning out lights and shutting off equipment.
10. Seal leaks in ductwork. Use code approved tapes and/or caulking.
11. Insulate all chilled water lines, refrigerant suction lines and cold air ducts. Note: consult the AHERA Plan before disturbing possible asbestos building materials.

DOMESTIC WATER SYSTEMS

1. Set water temperatures at recommended levels.
2. Shut off water-using equipment when not in use.
3. Install time clock to control domestic hot water pumps.
4. Adjust flush valves for minimum use.
5. Install flow limiting shower heads.
6. Consider automatic shut-off showers and water taps.
7. Use cold water for the first rinse of dishes.
8. Use the dishwasher only when it is filled.

MISCELLANEOUS

1. Caulk around all door and window frames.
2. Weatherstrip all doors and windows.
3. Consider sealing gravity vents in storage rooms.
4. Cover window air conditioners and caulk around them in winter.
5. Use vestibule doors if they are in place.
6. Check that door closures are working properly.
7. Keep desks away from outside walls as much as possible.
8. Keep condensers clean on air conditioning units, drinking fountains, refrigerators, freezers, milk coolers, etc.
9. Check door gaskets on refrigerators and freezers.
10. Use light colored reflective paint when repainting.
11. Consider installing twist timers on exhaust fans with manual switches.
12. Post signs near electric power consuming machinery urging it be used sparingly, preferably during off-peak hours.
13. Turn off equipment (i.e., refrigerators, freezers, ovens) not being used.
14. Encourage students, faculty, and staff to utilize blinds and curtains to help insulate the building. Closed blinds and curtains on south and west exposures will help keep a building cool in summer, while open blinds or curtains will help warm the building in winter.
15. Develop detailed shutdown program for maximizing energy savings during holidays and se-

mester breaks use an abbreviated program for weekends.

16. Do not hold exterior doors open during passage of occupants at start and finish of the day. Limit the number of entrances used during arrival and departure hours. Keep door closures in good repair; remove hold-open devices.
17. Where feasible, eliminate use of north and west entries in cold weather, especially in elementary buildings where usage of entries is very high. If north and west entries must be used, provide an exterior wind break to eliminate the wind tunnel effect.

ENERGY CONSERVATION TECHNIQUES FOR THE HVAC SYSTEM

CENTRAL BOILER PLANTS

Central boiler plants utilize many types of boilers and supporting equipment. The following general recommendations apply to most central boiler installations and should help improve the efficiency of your operation and save energy.

OPERATING PROCEDURES

1. Institute an operating procedure for multiple boiler plants to ensure maximum loading on one boiler before a second boiler is put into service. Example: Two boilers operating at 40% of capacity would operate at 7% less efficiency than one operating at 80% of capacity.
2. Turn off and isolate equipment such as boilers and pumps not in use for the summer season.
3. Adjust firing rate to the load, not to the boiler capacity. Too high a rate will cause short cycling and excessive fuel consumption.
4. Set pressure control on steam boilers as low as possible to achieve required output.
5. Maintain the lowest possible boiler water temperature suitable for good equipment performance.
6. Avoid excessive boiler blowdown. While boiler blowdown is essential, excessive frequency needlessly drains hot water and wastes energy. The proper frequency will depend upon such factors as water purity and type of water treatment. Consult with a water treatment contractor to establish a schedule and then stick to it. For certain newer types of boilers, manufacturers may not recommend water treatments; double check to be certain.
7. If possible, use warm air from ceiling of boiler room and exhaust air from other spaces for combustion air instead of cold outdoor air. (Note: This method requires very careful analysis by a mechanical engineer.)
   Example: A 300 HP boiler using air from an exhaust system at 75°F for combustion will require 1¾ gallons less oil per hour than it will if 20°F outside air is used.

MAINTENANCE PROCEDURES

1. Have heating system inspected annually by a competent heating contractor.
2. Check combustion efficiency periodically by taking readings of CO$_2$ and stack temperature. Oil burner and air supply should be adjusted for maximum efficiency. Flue gas analysis should show a CO$_2$ reading of no more than 9-10% for gas fired units and 11.5-13.8% for oil fired units.
3. Inspect combustion controls. Have them calibrated annually by proper service people in order to maintain maximum efficiency of operation.
4. Inspect boilers on a scheduled basis for evidence of deposits of soot, scale, and slag. Remove all deposits on any heat transfer portion of the fireside of the boiler. Surfaces should be scraped, brushed, or vacuumed.
   Example: A $^{1}/_{8}$-inch thick layer of soot could result in 8% loss of efficiency.
5. Check stack temperature against manufacturer's data for the particular unit. (Install a thermometer in flue outlet if one is not already there.) In general, stack temperatures should be not more than 150° F above steam or water temperature. A rise in temperature is usually an indication of dirty heat transfer areas or poor adjustment of burner and controls. This is a quick way to detect a malfunction of equipment and to alert the operator to an adverse condition or inefficient operation.
6. Check chimney daily to determine if there is any visible smoke. Smoke indicates a malfunction of the burner or controls. The result is inefficient combustion.
7. Check fuel oil pumps daily to ensure correct oil pressure and flow to burners.
8. Check fuel oil pump glands for tightness. Lubricate motors. Leaking fuel wastes energy.

9. Inspect oil burner nozzles daily. Clean or replace as necessary with proper size nozzles.
10. Check gas burners and set for correct gas flow. Remove mineral or corrosion buildup on burners and burner parts.
11. Clean the water side of the heating surface by washing out with chemicals as recommended by the manufacturer. Use water treatment to maintain a clean water side condition and set up a program for checking water treatment.
12. Give special attention to keeping water legs clean. Most cast iron boilers have water leg tappings with plugs. By replacing the plug with a nipple and a cap, access for cleaning will be easier. By extending the nipple through the insulation, damage to insulation can be avoided during cleaning.
13. Inspect combustion chamber refractory for deterioration, cracks and oil leaks. Repair or replace as required.
14. Seal all air leaks in boiler. Inspect the boiler enclosure and insulation to make sure they are in good condition. Seal all cracks that would allow heat to escape.
15. Seal spaces between sections of cast iron boilers in accordance with manufacturer's recommendations.
16. Seal flue connection to boiler, stack and between sections.
17. Install water treatment system on hot water and steam systems if needed. Deposits reduce heating efficiency.
18. Provide automatic ignition rather than standing pilots.
19. Provide indoor-outdoor controls to raise or lower boiler water temperatures as outdoor temperature rises or falls.
20. Provide an automatic draft-damper control on new boilers to reduce heat loss (up the chimney) when the burner is not in operation. Have draft-damper control adjusted by experienced personnel. Flue losses can contribute up to a 20 percent higher fuel consumption per year.

CENTRAL CHILLED WATER PLANTS

Central chilled water plants are used to produce chilled water that is piped to cooling coils in air-handling units. Many different types of water chillers are used for this purpose, including units with reciprocating, rotary, and centrifugal compressors. Steam absorption type chiller units are also used. Auxiliary equipment commonly includes condenser water and chilled water pumps, cooling towers and evaporative or air-cooled condensers. The following are guidelines for keeping the systems operating efficiently and saving energy.

OPERATING PROCEDURES

1. When multiple chiller installations are operating at low loads, do not put a second chiller on the line until the first one is up to load. Normally, less energy is used by one chiller operating at 90% of capacity than by two chillers, each at 45% of capacity.
2. Use outside air when possible to reduce cooling system loads. Let mother nature work for you as follows:
   a. Where night temperatures are cooler, flush out your facility with outside air before shutting off ventilation systems
   b. Use cold outside air for cooling when outside temperatures are satisfactory (commonly called an economizer cycle)
3. Produce chilled water at the highest temperature that is compatible with the equipment using the chilled water. Less energy is needed to produce chilled water as the temperature setting is raised.
   Example: An electrically driven centrifugal water chiller will use about 10% less HP when producing chilled water at 48°F rather than at 42°F.
4. Raise the temperature of water leaving the chiller as the air conditioning load reduces.
5. Make use of lower condenser water temperatures for chillers that are not limited to 85°F condenser water. Newer chillers can take condenser water at 60°F. In such cases, keep fans running and the colder condenser water will save power at the chiller.
6. When a chiller is out of service, shut down its condenser water pump and chilled water pump.
7. Cycle cooling tower fans on old systems as the load varies to keep the condenser water at a constant temperature.

MAINTENANCE PROCEDURES: CHILLERS

1. Check efficiency of chillers; check water temperatures in and out of condensers; check chiller against design specification; check amperage on compressor motor against manufacturer's data.
2. Clean condenser tubes annually.
3. Watch for unusual compressor operation such as short cycling; determine cause and make corrections.

4. Check all joints for refrigerant leakage. Repair as necessary.
5. Check purge operation for signs of air or water leakage. Make corrections as required. Such leakage adversely affects efficiency and wastes energy.
6. Check gauges and thermometer on equipment frequently. If variations from design conditions are noted, make necessary corrections. Calibrate instruments periodically.
7. Lubricate all bearings and other moving parts.
8. Inspect liquid indicator on a regular basis. Follow manufacturer's instructions for signs of moisture in refrigerant or for low refrigerant.
9. Lubricate drive motors.
10. Examine speed reducing gear boxes for proper lubrication, gear condition, thrust and main bearing condition.
11. Where belts are used, see that all have equal tension.
12. When belts are frayed or need replacing, replace the entire set.

CENTRAL CHILLED WATER PLANTS

MAINTENANCE PROCEDURES: COOLING TOWERS

1. Check blowdown rate to be sure dissolved solid concentrations are at acceptable levels. Do not over blowdown; this wastes chemicals and water.
2. Clean spray nozzle, remove scale and dirt. Scale on spray nozzles reduces water flow. A poor spray pattern reduces the efficiency of the tower.
3. Inspect tower for algae growth. If algae is found, clean tower and institute water treatment with algicides.
4. Check fans for proper air quantity as recommended by manufacturer.
5. Check tightness of fan belts.
6. Check alignment of motor and fan.
7. Lubricate fan and motor bearings regularly.
8. Ensure tower discharge air does not enter the tower inlet. If it does, add baffles or higher stack at discharge.
9. Check water level in tower. If overflowing, reset the make up water control.

MAINTENANCE PROCEDURES: AIR COOLED CONDENSERS

1. Check all refrigerant connections for leaks. Repair as required.
2. Keep condenser coil face clear of leaves, dirt and other obstructions to air flow.
3. Ensure that hot air discharge is not entering the air inlet.
4. Confirm that specified air quantity is being handled by the fan.
5. Lubricate fan and motor bearings.
6. Check alignment of fan and motor when belt driven.

MAINTENANCE PROCEDURES: EVAPORATIVE CONDENSERS

1. Check all refrigerant connections for leaks. Repair as required.
2. Clean coil surfaces by washing and brushing.
3. Clean spray nozzles or water distribution devices to maintain even water flow.
4. Use water treatment if the water spray leaves a deposit on the coil fins.
5. Ensure that there is no air passage from the unit outlet to the inlet.
6. Confirm that proper air quantity is being handled.

DISTRIBUTION SYSTEMS

Distribution systems are used to transfer heat between the primary equipment (boilers, chiller, etc.) and the conditioned space. Energy is required to move given quantities of distribution media (air, water, etc.) against the friction of the system (pressure drops through equipment, coils, piping, ductwork, filters, strainers, dampers, etc.).

OPERATING PROCEDURES: MECHANICAL VENTILATION

1. Review amount of fresh air being used at minimum conditions. The direct air flow is not proportional to the opening of volume dampers (20% open, 50% open, etc.). To determine the correct damper position for the required fresh air quantity requires testing with an anemometer and should be done only by experienced personnel.
2. Check manual dampers with exterior locking devices to ensure locking device position indicator does indicate true damper position.
3. Shut off air conditioning, ventilating, and exhaust systems for rooms not occupied.
4. Turn off supply and exhaust fans when not needed.
5. Close air supply ducts and exhaust duct dampers when not in use. In cold weather, the failure to do this will result in the infiltration of cold air and a lowering of the temperature to an uncomfortable level.

6. Operate exhaust systems intermittently where possible (i.e., operate toilet exhaust from light switches; turn off exhaust fans when not needed).
7. Check size and speed of exhaust fans and limit to actual needs.
8. Provide baffles so that the wind does not blow directly into an outdoor air intake.
9. If possible, use outdoor air for cooling rather than mechanical refrigeration. Use the economizer cycle, if available.
10. Provide controls to prevent fresh air dampers and exhaust fan from bringing in outside air until space has heated up or is occupied and requires ventilation.
11. Consider a CO_2 sensor to reduce ventilation requirements in large meeting rooms, garages and other areas with large exhaust requirements.
12. Install automatic timers to de-energize exhaust fans, supply fans and fresh air intake dampers during unoccupied periods.

Maintenance Procedures: Steam Distribution System

1. Check steam distribution traps for leakage. Repair or replace traps as required. Traps that are passing steam are extremely wasteful. Example: A steam trap with a 3/8-inch orifice on a 100 psi line passing steam will waste 470,000 lbs. per month.
2. Check condensate tank vents for a visible plume of steam. This is an indication of blowing steam traps. Locate faulty trap and repair.
3. Ensure that steam condensate is returned to the feed water tank for reuse.
4. Inspect and clean strainers on hot water lines, steam lines, and condensate lines.
5. Check all packing glands, valves, and joints for leaks. Repair as required.
6. Check operation of pressure reducing and regulating valves. Adjust, repair or replace as necessary.
7. Check circulating pump glands for tightness. Hot water leaks waste energy.
8. Keep rotating equipment and motors properly lubricated. Lack of lubrication increases friction and wastes energy.

Maintenance Procedures: Insulation on Pipes and Ducts

1. Replace all damaged insulation on pipes conveying heated or cooled liquids.
2. Insulate piping that conveys heated or cooled liquids.
3. Replace damaged insulation on ductwork and apparatus handling heated or cooled air.
4. Insulate bare heating lines.
5. Insulate or repair insulation on heat exchangers and condensation tanks.
6. Insulate air conditioning supply ducts passing through non-conditioned spaces and above suspended ceilings.
7. Protect insulation from water and moisture.

Maintenance Procedures: Air Distribution System

1. Have air distribution system balanced so that each room or air outlet gets the proper amount of air.
2. If energy conservation suggestions that reduce the amount of air needed for air conditioning have been implemented, determine new air quantities and reduce fan speed accordingly.
3. Determine if there is air leakage into or out of ductwork. Seal leaks by taping, caulking, or other means.
4. Look for air leakage at the central air handler, around coils, casings, access doors, and at joints in casings. Seal all leaks.

Maintenance Procedures: Coils

1. Clean heating, cooling, and condensing coils regularly and frequently. During use, lint or dust collects on the finned surfaces and increases the resistance to air flow. This decreases the effectiveness of the surfaces, so more fan horsepower is required, wasting energy.

Maintenance Procedures: Dampers

1. Examine all automatic dampers for leakage when in closed position. Reset linkage or replace dampers if blades do not close tightly.
2. Inspect automatic dampers for proper operation. Reset as required.
3. Clean and oil linkages periodically to ensure proper operation.
4. Ensure that all dampers to the outside air intake or exhaust connection are fully closed when equipment is shut off.
5. Check the air distribution system dampers. If the majority of the dampers are closed or partially closed to "balance" the system, consider reducing the fan speed and opening some of the dampers to save fan horsepower.

Maintenance Procedures: Filters

1. Clean or replace filters and continue to do so

on a regular, frequent schedule. Ventilating units have filters that become dirty with use. When this happens, resistance to air passage increases and more fan horsepower is required, wasting energy. The schedule should be based on experience in the area.

2. Use a filter gauge at filter banks to indicate the pressure drop through the filters. When pressure drop exceeds design figure, clean or replace air filters.
3. Periodically examine electronic air filters for excessive accumulations on the plates. Follow the manufacturer's instructions for cleaning.

MAINTENANCE PROCEDURES: MOTORS

1. Check alignment of motor drive to fan. Adjust motor base for proper alignment.
2. Lubricate motor bearings.
3. Check for excessive noise or vibration. Determine cause, such as worn bearings. Replace worn bearing.
4. Check motors for overheating. This may be due to over-loading, lack of ventilation or other functional problems.
5. Check motor amperage against nameplate data. If above rated amperage, reduce fan speed, use larger motor or otherwise reduce load on motor.

MAINTENANCE PROCEDURES: FANS

1. Clean fan blades.
2. Lubricate bearings.
3. Adjust or replace fan belts to ensure proper fan belt tension.
4. Determine cause of any excessive vibration or noise and make corrections.
5. Check fan speed against design conditions. Adjust or replace sheaves as required.

Part II—The Role of Administration

Administrators and Energy Conservation

The Numbers

One problem facing many school districts is the drastic increase in costs of energy needed to operate the schools. Basically, school budgets can be divided into two categories: The first section is composed of salaries and fringe benefits; the other is referred to as discretionary monies and includes special programs, supplies, support services, extracurricular activities, and energy costs.

In the average school district, salaries and fringe benefits represent between 75 and 80 percent of the entire budget. For example, a school district with a total budget of $8 million might allocate its funds as follows:

$6 million	Salaries and Fringe Benefits
$2 million	Discretionary Monies
$8 million	TOTAL BUDGET

In many districts, the sudden and rapid increase in the cost of energy has drastically altered utilization of discretionary monies. In 1976, energy required about 12 percent of the discretionary monies; by 1978 energy costs had doubled and required 25 percent. By 1980, energy costs had risen to 32 percent of the discretionary monies in many areas of the country. *With the predicted increases in the costs of natural gas, energy costs may soon require 40 to 50 percent of many schools' discretionary monies.*

Per pupil energy costs is another way to look at the same phenomenon. Nationally, in 1972-73, school energy costs averaged approximately $20 per pupil; in 1974-75 energy costs increased to $29 per pupil; by 1978, energy costs doubled to $57 per pupil. Today, schools that have engaged in substantial energy conservation programs pay approximately $100 per student while districts that have not established programs average $130 per pupil for energy.

No one knows for sure what energy will cost in future years. Some experts project that expenditures for natural gas may increase by *30 percent per year* and for electricity by *17 percent per year* over the next five years. If true, this would represent a huge increase in the cost of natural gas and electricity, and impact budgets tremendously.

Based on the inflationary possibility, administrators must begin to manage energy use. The following pages provide suggestions for management practices to help reduce energy use.

Administrative Organization For Energy Management

There are three steps needed to identify and manage energy use:

1. A district-wide commitment to energy conservation management including the board of education, staff, parents and the community.
2. One person or department charged with developing and implementing the energy management plan and processes.
3. Dedication to commit resources, time, money, and support systems to follow through with the plan.

Commitment, organization, and implementation are the three keys to energy management. The challenge is clear and well-defined, probably one of the clearest a school district will ever face. Similarly, the responses, in an engineering sense, are also clear, and success can be guaranteed. But the major ingredient usually lacking is organizational commitment—based on a realization that energy challenges are here to stay and must be addressed on a continuing basis. If commitment can be developed within the school district, the district can form organizational responses to continuing energy challenges.

Engaging Board of Education Support

The school board's commitment to energy conservation is a key link between the community and its school system. Traditionally, board policy is the school system's guide, authorization, and mandate. A strong board policy for energy conservation tells administrators, teachers, and other staff that:

1. This board and community believe in saving energy.
2. This community views excessive energy use as wasted tax money.
3. This community wants the school system to actively pursue reasonable ways to save energy.

This is the traditional function of the board policy, but there are also added benefits to a strong energy policy statement. It publicizes the district's efforts to the community and helps enlist the support of various community groups in organizing and implementing district and community energy-management plans. A strong board policy, along with a successful energy program, can reduce the impact of escalating energy costs. In addition, energy management planning in the school system could provide leadership and encourage cooperation among the various community agencies, groups and governments in a combined effort to save energy. A suggested board policy on energy is presented for consideration.

DRAFT OF PROPOSED POLICY STATEMENT

POLICY NO. ________

ENERGY CONSERVATION POLICY STATEMENT

Declining levels of natural energy resources mandate that the school district develop and implement plans to conserve all forms of energy used in the schools. The need to participate in conserving the nation's energy resources and the economic reality of increased costs of utility services require that an energy conservation program be supported by all school district personnel.

Therefore, the Board of Education directs the Superintendent to develop and implement both immediate and long-range plans designed:

1. To conserve energy resources by the school district
2. To provide educational experiences within the curriculum for students that will instruct and assist in developing energy awareness, conservation and alternatives

Progress reports on the implementation of energy conservation measures shall be made to the Board of Education at least semi-annually.

ENGAGING OTHER ADMINISTRATIVE SUPPORT

Whatever the size of the school system, *the superintendent's commitment to energy management is essential.* To a great degree, the superintendent determines the potential for success of any school district's energy plan or program. The superintendent and his staff are responsible for implementing the plan. It should include the following five items:

1. Goals and objectives
2. Management direction and personnel assignments
3. Resource allocation and control
4. Program monitoring and evaluation
5. Periodic reporting to the Board of Education

A sample of administrative regulations for a school energy conservation program is shown on the last pages of this section.

The administration must exercise the same functions for the energy management program as it does for any other school program. Commitment requires continuing and consistent support. Offhanded or autocratic goal-setting by the administration may kill an energy management program before it begins. For an energy program to succeed, each administrator must know that the superintendent views the program as imperative and applicable to all units within the system.

There will be difficult decisions for superintendents, central administrators and principals in energy management. Among the most difficult are those to be made on after-school and, to a greater extent, evening activities between October and March. School administrators must have a clear understanding of their system's commitment to energy management in order to make sound decisions.

ENGAGING OTHER STAFF SUPPORT

Teacher and support staff commitment is important to the success of an energy management program and must be developed by administrators as part of the plan. Maintenance and custodial staff support is generally immediate and enthusiastic. Student cooperation is needed, particularly in high schools and middle schools. Moreover, the student commitment to energy conservation is important in the learning process, since energy conservation will remain a challenge throughout their lives.

ORGANIZING THE ENERGY MANAGEMENT TASK

There are seven major tasks or processes characteristic of a successful energy management program:

1. A board of education policy that clearly states its commitment for a strong energy management program.
2. A small, strong, persuasive, district-wide energy conservation committee appointed by and responsible to the superintendent.
3. A task force in every school plant in the district where appropriate
4. Specific responsibilities assigned to specific individuals.
5. Careful planning in developing energy use guidelines and monitoring procedures.
6. A management system, including energy use records and energy mini-audits, for each building in the district.
7. Periodic follow-up, reporting and evaluation efforts to see that established energy usage guidelines are followed.

How a district organizes to accomplish these tasks will depend on its size, staffing patterns and administrative structure. However, many districts have found *the appointment of an energy management officer and an energy committee is a good way to start.*

ESTABLISHING THE DISTRICT ENERGY CONSERVATION COMMITTEE

Energy management must be a team effort. Any conservation effort, if it is to be successful, must have the cooperation from everyone in the educational community. The size and composition of the team will vary according to the needs and aims of the school district. The energy conservation team might involve the following people:

1. The superintendent or designated representative
2. The business administrator
3. A building principal or designated assistant
4. an energy management officer (see following paragraph)
5. A board of education representative
6. A teacher
7. A maintenance or custodial staff member
8. A represenative from food services
9. A representative from the PTA
10. A representative from a utility company
11. other professional members such as an architect or engineer
12. A transportation staff member
13. The director of public information.

Careful selection of persons sincerely interested in the project and willing to participate actively is essential.

THE ENERGY MANAGEMENT OFFICER

An early step is to appoint an energy management officer to be responsible for administering the energy conservation program. Duties should include the following six tasks:

1. Collecting utility consumption data for all buildings.
2. Conducting energy audits for each building.
3 Formulating energy conservation guidelines for the district.
4. Assisting in program implementation.
5. Recommending mechanical/electrical equipment and building changes designed to conserve energy.
6. Maintaining data to ensure that results are achieved in the energy management program.

The position of energy management officer can be part or full-time, depending on the size of the district. However, *the success of the program requires that it be the assigned manager's responsibility.* The officer's appointment should be publicly announced and given both internal and external significance with duties and responsibilities clearly stated.

SUMMARY OF THE ADMINISTRATOR'S ROLE IN ENERGY CONSERVATION

A successful energy management program must be administered with the same skill and care as other important programs in the district. In order to do that, an administrator should develop an Energy Management Plan including the following:

A. Goals and Objectives
  1. To establish a 10-30% reduction in energy use through operational and maintenance changes.
  2. To foster an energy ethic in staff and students.
  3. To establish a database.
  4. To train the staff.

B. Management Direction and Personnel Assignments
  1. Energy Conservation Committees (district-level, building-level)
  2. Appointment of an Energy Management Officer—responsible for:
    a. Collecting data
    b. Auditing energy consumption
    c. Recommending action
    d. Implementing the program
    e. Monitoring progress
    f. Maintaining data for determining energy efficiency of new construction

3. Information Dissemination for Increased Commitment
   a. Include energy conservation on agenda of every staff meeting at beginning of year and periodically during the year
   b. Make use of internal and external publications to tell the energy story
   c. Get teachers and students involved in energy conservation education

DRAFT OF PROPOSED ENERGY CONSERVATION ADMINISTRATIVE REGULATIONS

No.__________

Declining levels of natural energy resources and the economic reality of increased costs of utility services mandate that an effective energy conservation program be adopted on an immediate and long-range basis.

Strong commitment and support will be expected from all school district administrators, staff and students.

Energy conservation program development, management and implementation will be as follows:

SCHOOL DISTRICT ENERGY CONSERVATION COMMITTEE

The Superintendent shall appoint this committee, limited in number for effective functioning, comprised of school district staff and selected citizen members who have special expertise in this area.

The purpose of the committee will be to assist in formulating and establishing immediate and long-range program priorities and to review and evaluate progress. The committee shall meet at least quarterly.

ENERGY CONSERVATION ADMINISTRATIVE TEAM

This team will be comprised of the Deputy Superintendent for Administrative Services, the Director of Public Information and the Director of Physical Plant and Transportation.

This team will be responsible for decision making and employee adherence to policies and regulations. The team will be involved in budgetary and capital outlay priorities and will be the reporting unit to the School District Energy Conservation Committee on a semi-annual basis.

ENERGY MANAGEMENT OFFICER

The Director of Physical Plant will assume responsibility as the Energy Management Officer. Responsibilities shall include: maintenance and reporting of utility consumption data for all buildings; completing energy audits for all school district buildings, formulating energy conservation guidelines for buildings and assisting in implementation, recommending and/or providing cost data for mechanical/ electrical equipment and building changes designed to conserve energy, and maintenance of data showing results achieved in the energy conservation program.

Note: This is a sample set of regulations. Districts should modify to fit their own needs and personnel.

PART III—DATA COLLECTION FOR ENERGY CONSERVATION

MEASURING, RECORDING AND USING ENERGY CONSUMPTION DATA

PREPARING TO RECORD DATA

Energy data serves as a needs assessment and evaluation function as well as providing timely warning signals of mechanical or operational failures. Accurate, comprehensive data on energy consumption helps a school district do the following:

1. Set preliminary and continuing benchmarks for the energy program
2. Set priorities for action
3. Evaluate the program's success

This section will describe data systems for energy conservation.

THE BUILDING SURVEY

The *first task* in establishing an energy records system is to survey the district's buildings and establish a way to identify and measure all energy used. There are five forms of energy widely used in school districts: (1) electricity (purchased or generated); (2) purchased steam; (3) oil; (4) natural gas; and (5) coal. (Wood may appear again as a significant fuel in the future, as may supplemental solar energy, solid waste, and wind power.)

To be sure all forms of energy are measured, a building-by-building survey can be used to identify energy sources and to locate the corresponding meters, gauges, dipsticks and scales. The construction history of school buildings can make this a challenging task; for example, progressive expansions of a building can lead to both oil and gas heat in a building served by more than one meter. No source of energy can be overlooked, or the resulting energy-records system will be grossly inaccurate. The local utility company representative can assist in this survey.

An important part of the survey is ensuring that the gas and electric meters are operating and properly calibrated. Under law, local utility companies are responsible for meter operation and proper calibration, typically on a five-year schedule. However, it is prudent for the school district's energy officer to check, perhaps annually, to be sure the meters have been tagged as calibrated, reconditioned, or replaced within the time intervals specified by the utility supplier.

Oil gauges, where they exist, are usually the responsibility of the school district, and the energy officer should be sure these responsibilities are carried out. Purchased steam metering is usually maintained by the supplier, and these arrangements should be monitored by the district's energy officer.

DATA DECISION-MAKING

The *second task* in preparing an energy-records system is assigning the responsibility for collecting the data and establishing the frequencies. This is a major step because the assignment and frequencies are significant cost/benefit decisions that reflect, and indirectly influence, the directions the energy management program will follow.

Consider these three points when determining data collection frequency:

1. Monthly readings are extremely important, both as a rough check against utility bills and for assessing the energy conservation program. Good last-day-of-the-month data is generally valuable enough to justify any overtime payments or other special efforts required to ascertain this information.
2. Daily or weekly data is important not only to

instill the constant energy-awareness a good program requires but also to spot wasteful trends early.

3. Overemphasis on frequent data collection can be expensive and draw attention away from the main focus of the program.

DATA COLLECTION SUPPORT AND PAPERWORK

The third and final task of preparing the energy records system is to create the necessary clerical and administrative support for the collection frequencies and calculations. Every data collector (meter reader) must be provided with answers to the what, where, when, and how questions. In some New Jersey districts these answers have been provided through meter inventory and labeling, data collection sheets, and instructions in meter reading.

METER INVENTORY AND LABELING

Each data collection point for a building can be tagged with labels. If there is a multiplier built into the meter, it should be noted clearly on the label. The locations and characteristics of the data collection points are then summarized on an inventory sheet that is given to the data collector. It is also prudent to post a copy of the inventory in the building's custodial room or boiler room—not tacked on a bulletin board near the telephone or taped to the wall, but fixed in a separate plexiglass holder, in a locked display case, or in the book of the building's operating and maintenance instruction sheets. (See Meter Inventory below.)

METER INVENTORY

BUILDING____

ELECTRIC

E1	Location	__________	E3	Location	__________
	Meter number	__________		Meter number	__________
	Number of dials	__________		Number of dials	__________
	Multiplier	__________		Multiplier	__________
E2	Location	__________	E4	Location	__________
	Meter number	__________		Meter number	__________
	Number of dials	__________		Number of dials	__________
	Multiplier	__________		Multiplier	__________

GAS

G1	Location	__________	G3	Location	__________
	Meter number	__________		Meter number	__________
	Number of dials	__________		Number of dials	__________
	Multiplier	__________		Multiplier	__________
G2	Location	__________	G3	Location	__________
	Meter number	__________		Meter number	________
	Number of dials	__________		Number of dials	__________
	Multiplier	__________		Multiplier	__________

DATA COLLECTION IN THE FIELD

NATURAL GAS METERS

Errors in meter readings are responsible for most of the difficulties in keeping accurate energy data. Meter reading is a tricky matter because we are accustomed to dials that turn in one direction—clockwise. Meter dials move clockwise and counter clockwise. Meter readers must be aware of this when taking readings.

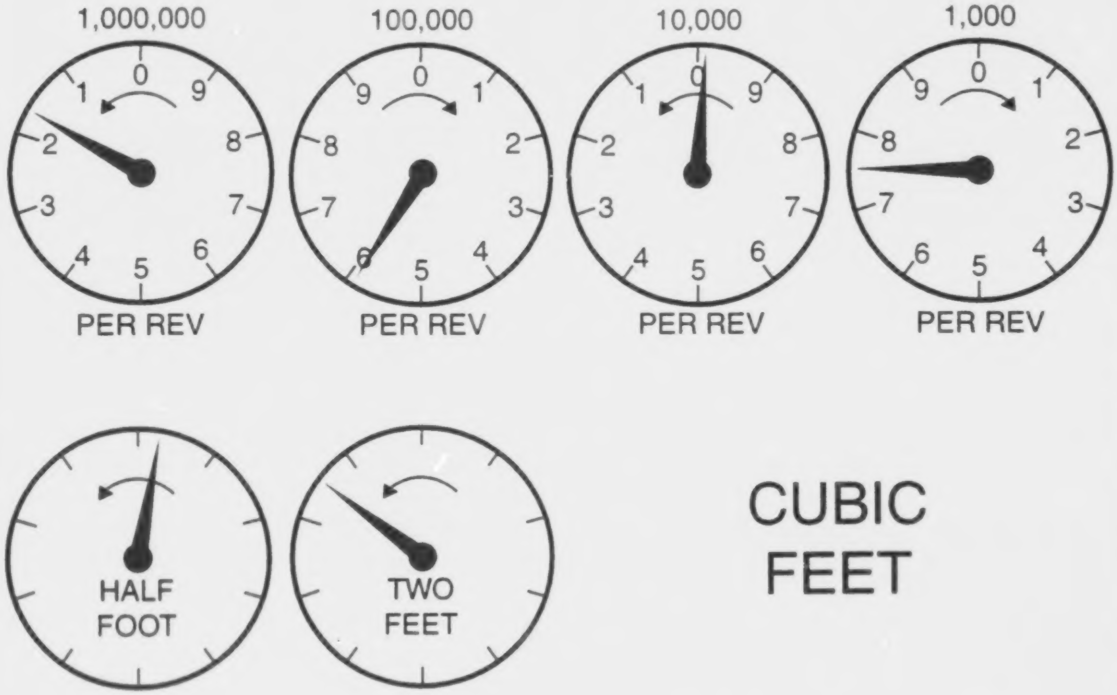
Figure 1 shows a gas meter, easily recognized because it is marked in cubic feet. The top row of dials is the important row. The "half foot" and "two feet" dials are used to calibrate the meter and test consumption of gas fired appliances.

To read the meter, begin with the lowest-value dial. In the example, this is the 1,000 cubic-foot dial—*farthest to the right.* The pointer is between seven and eight, so it is read as seven. *Always use the lower value on a dial when reading.* Moving left to the next dial, we see that the hand is between nine and zero. So, the reading is nine. The third dial from the right shows a pointer not yet at six. So, the proper reading is five.

The far left dial show the pointer between one and two, therefore, it is read as one. Be certain of your reading because errors can be costly.

The correct reading for Figure 1 is 1597. By adding the proper zeros for each dial, we see that 1,509,700 cubic feet of gas has passed through this meter. By subtracting this number from your next reading (which will be higher) you can determine how much gas was used between readings.

FIGURE 1



As a test, read the meter in Practice Exercise 1.

Note: Check with the gas company servicing your area to determine the type of meter installed in your buildings. Natural gas consumption is reported in various units—hundreds or thousands of cubic feet (CCF, MCF). Know the units used on your meters.

ELECTRIC METERS

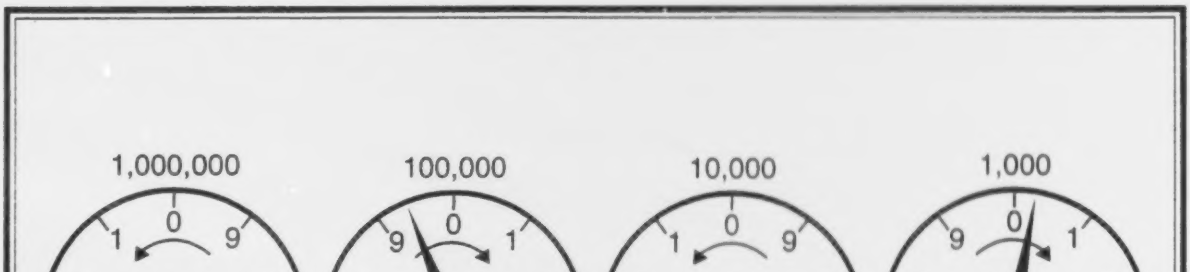
Electric meter data is read and recorded just as with gas meters. Where there is a great amount of electricity used, electric meters have "multipliers." Unfortunately, many of these multipliers are not divisible by ten, so the data collector must multiply the difference between meter readings by the multiplier to calculate consumption. For example, if a meter has a multiplier of 145 and shows a monthly meter difference of 186 KWH, consumption is actually 26,970 kilowatt hours of electricity (186 KWH x 145).

OIL TANKS

There are two ways to measure fuel levels in oil tanks. First, some districts are equipped with bubbler style or mechanical gauges to indicate the level of fuel in the tank. The gauge reading is then converted to gallons by checking the tank chart. Second, oil tank dipsticks are often used, either as the only way to measure the tank or as a backup for the bubbler style or mechanical gauge. A dipstick marked in gallons is the most convenient, eliminating conversion through any tank chart.

Data problems can occur when the tank is being refilled. To avoid confusion, take a reading immediately before and immediately after the refilling. This also serves as a check on the delivered amount.

PRACTICE EXERCISE 1



(See page 25 for correct answer.)

Oil tank soundings are particularly important because there is no external reference to use to check consumption. Electric bills and gas bills are an external means of verifying the district's readings, but oil deliveries can be erratic, poorly billed, and *always reflect only supply, not consumption.*

COAL AND OTHER SOLID FUELS

Ideally, these fuels should be weighed as burned. Before the vision of a one room school teacher carefully weighing wood for the stove destroys this section, however, remember that reason should be the guide.

Another method is to establish the weight of a standard load or scoop load and count the number of loads. Whatever the method, if the heater or boiler is reasonably large, the data should be accumulated and checked occasionally, both directly and by comparison to deliveries. *Tracking solid fuel consumption by deliveries is impossible, since deliveries only determine supply not current consumption.*

RECORDING DATA

The composition of the data collection sheets will vary with the decisions a school district makes on data collection frequencies and responsibilities. Remember, an energy records system *must be tailored to the needs of the district and the abilities of the personnel assigned to data collection.* Applying somebody's "one best way" will hobble the energy management program.

The important thing is to record the correct usage. For electric meters, make sure the form indicates any multiplier. For natural gas meters, the form should include the multiplier and any correction that is necessary. It is important that all meters are read; check against billings and/or call the utility companies. When the data is collected, it should be consolidated and used as a management tool.

See page 26 for a sample form on Meter Reading. Additional sample forms for meter reading/ recording, plus a form for compilation of a building's total monthly consumption data, are included in the Appendix.

CALCULATING ENERGY CONSUMPTION DATA

After calculating energy data, including the annual energy use of each facility, it is possible to begin to make comparisons between buildings in the district as well as comparing your consumption with that in other school buildings throughout the state. When the following data for each building is available, the information should be converted to BTUs/square foot:

1. The square footage of the facility requiring heat or air conditioning
2. The annual usage of energy in the categories of cubic feet of gas, KWH of electricity, barrels of oil or any other forms of energy provided to the district

Expressing energy in BTUs allows comparisons of total energy used between buildings or between districts. The BTU is a measure of energy used by engineers. All forms of energy can be converted to BTUs and thus comparative efficiencies can be examined. Figure 2 shows the BTU values of various energy forms.

ENERGY EFFICIENCY COMPARISONS

Figure 3 (on page 29) includes target figures for energy consumption for school districts in the northeast. These

FIGURE 2

CONVERSIONS TO BTUs

Energy Form	BTU Equivalent
1 cubic foot natural gas	1,030
1 gallon #2 fuel oil	138,690
1 gallon #6 fuel oil	149,690
1,000 lbs. steam	1,390,000
1 standard short ton coal	24,500,000
1 kilowatt hr. electricity	3,413

(Answer for the reading Practice Exercise 1 is 6950.)

SDEP SAMPLE FORM
METER READING

Building_______________________
Meter___________________ Meter Number__________________________ Prepared by____

	Electricity (Multiplier________)			Natural Gas		
Reading Date*	Meter Reading	Difference from Previous Reading	KWH Used	Meter Reading	Difference from Previous Reading	CCF Used

*Compute from bottom for easy calculation.

Using the values shown in Figure 2, energy usage data can be converted to BTUs per square foot per year as shown below.

ELECTRICITY

$$\frac{\text{Annual KWH} \times 3413}{\text{Square Footage}} = \text{BTUs/sq ft per year}$$

NATURAL GAS

$$\frac{\text{Cu Ft of Nat Gas} \times 1030}{\text{Square Footage}} = \text{BTUs/sq ft per year}$$

#2 FUEL OIL

$$\frac{\text{Gallons of \#2 oil} \times 138{,}690}{\text{Square Footage}} = \text{BTUs/sq ft per year}$$

Below is an example of how usage data can be converted to BTUs.

PRACTICE EXERCISE 2

Assume a 29,400 square foot school building using 91,765 KWH of electricity and 3,451 cubic feet of natural gas. A calculation of BTUs per square foot is shown below.

ELECTRICITY

91,765 x 3413 BTU/KWH = 313,193,945 BTU

$$\frac{313{,}193{,}945 \text{ BTU}}{29{,}400 \text{ sq ft}} = 10{,}653 \text{ BTU/sq ft}$$

GAS

3,451,300 CF x 1030 BTU/CF = 3,647,539,000 BTU

$$\frac{3{,}647{,}539{,}000 \text{ BTU}}{29{,}400 \text{ sq ft}} = 124{,}066 \text{ BTU/sq ft}$$

TOTAL ENERGY CONSUMPTION = 134,719 BTU/sq ft

SAMPLE FORM

SUMMARY SHEET

ENERGY CONSUMPTION MATRIX

School District____

School Year	**1997-98**	**1998-99**	**2000-01**	**2001-02**
School Name Sq. Footage	Total BTUs/Sq.Ft.	Total BTUs/Sq.Ft.	Total BTUs/Sq.Ft.	Total BTUs/Sq.Ft.

FIGURE 3

Target Energy Consumption Figures for School Buildings After Implementation of an Energy Conservation Program

	Heading (BTU) Per Sq Ft	Electric (BTU) Per Sq Ft	Total BTUs Per Sq Ft
Elementary	68,000	12,000	80,000
Middle School	76,000	14,000	90,000
High School	84,000	16,000	100,000

figures assume efficient energy utilization. They will not apply to all buildings but can be viewed as "rule of thumb" levels for efficient energy usage. Of course, there are many factors that influence usage levels such as building size and location, sophistication of the programs and equipment, and hours of operation, but these figures can serve as a general guideline to begin assessing efficiency.

Analyzing Energy Consumption Data

After calculating BTUs/square foot for each building in the district for each energy form (gas, electricity, oil, etc.), the information can be put on an energy consumption matrix. The matrix summarizes energy consumption data for each building in the district and is very important in identifying the high energy users or energy hogs. A suggested sample ***Energy Consumption Matrix*** is shown on page 30. A suggested sample Building Summary Sheet is also included in order that building energy consumption may be easily compared from year to year.

Putting Energy Data to Use

Once energy consumption data is generated it is imperative that the information be distributed to all the appropriate individuals or departments. Decision-makers need the information if they are to understand and participate in the energy conservation program.

Energy information should be shared with the central staff and all building principals. If the principals are aware of the tremendous costs of energy, they will better understand the reasons for the conservation program and can begin working with their teaching and custodial staff to conserve energy and establish energy control policies for their buildings.

Monthly energy consumption data should be provided to central staff and administration. This can be done either through the administrative cabinet meeting or in a monthly packet or newsletter. The more people who are aware of the costs of the energy program, the greater the chance for a concerted effort to resolve problems and maximize conservation.

The data that has been collected should be used in developing the projected budget and for purposes of accountability. In addition, the data can be useful as a public relations tool. With good data a district can show community members the efforts the district is making to control and reduce costs.

Checklist for Using the Database

Here are some ways to best use your database:

1. To set priorities for action and help decide where to start
2. To compare consumption with other district, regional and national averages
3. To compare consumption between buildings within the district
4. To calculate simple paybacks to determine priorities for quick-fix and refit
5. To evaluate program success:
   a. By comparing year-to-year data—monthly/quarterly; by district/building (compare by using measurements of heating degree and cooling degree days)

TWO YEAR
ENERGY CONSUMPTION MATRIX

School District ______________________________

School Year	YEAR				YEAR			
School Name Sq. Footage	Electricity BTUs/Sq. Ft.	Gas BTUs/Sq. Ft.	Other BTUs/Sq. Ft.	Total BTUs/Sq. Ft.	Electricity BTUs/Sq. Ft.	Gas BTUs/Sq. Ft.	Other BTUs/Sq. Ft.	Total BTUs/Sq. Ft.

SAMPLE FORM

  - b. By calculating costs avoided and energy saved
  - c. By establishing a basis for reports to the Board
  - d. By preparing accounting for possible funding
6. To provide for consciousness-raising:
  - a. By publishing for each building
  - b. By sharing with administrators, teachers, staff and students
  - c. By giving recognition for greatest savings (Energy-Saver of the Month)
7. To rebate buildings for good conservation:
  - a. By giving share of monies saved to building for discretionary use

PART IV—ENERGY MANAGEMENT SYSTEMS

BENEFITS OF AN ENERGY MANAGEMENT SYSTEM

An energy management system can be a very effective measure for reducing energy consumption. The Energy Management System (EMS) can be used to monitor and control a building's or district's HVAC system, the major consumer of energy in academic buildings. A computerized energy management system (EMS) controls all key heating, ventilation, air conditioning and domestic hot water systems.

REMOTE SUPERVISION OF ENERGY SYSTEMS OPERATIONS

The EMS can be supervised from a remote location or from a school district office. (This would not be advisable for small districts.) Engineers and programers supervise and monitor building operations on computers linked to the EMS in each building via a phone line, T.V. cable system or even by radio.

Major benefits of an energy management system are:

1. *Energy savings* and cost avoidance due to more effective scheduling, electrical demand limiting, and better temperature control.
2. More timely *monitoring of system failures* and alarm reporting.
3. *Reduced man-hours* required to physically check equipment.
4. More accurate *problem identification* since all OFF-normal conditions are permanently programmed into the computer and a "message" can be printed out identifying possible sources of a malfunction .
5. Potential simplification of complex pneumatic control systems by letting the computer perform many functions normally requiring additional pneumatic hardware. Reduced complexity can *lower* pneumatic control maintenance costs and can reduce the possibility of breakdowns as well.

DETERMINING DISTRICT NEED FOR INVESTMENT IN EMS

Several factors must be considered when deciding whether the installation of an Energy Management System will provide the type of energy savings and payback that would make the initial investment attractive.

Energy Intensive Use
Is there a large number of supply fans, pumps, etc.? Is there a heavy use of air conditioning?

High Energy Consumption
Is there high electrical demand or consumption? Is there high fuel consumption?

Complex Controls
Are there pneumatic systems with a high degree of sophistication? Do these systems require many man-hours to effectively monitor and maintain them?

Diversity of Use
Are different areas of buildings used at different times? Is there a need for equipment scheduling from a central location?

Building Size
Does the size of the building make it difficult to effectively operate and monitor all the individual components of the HVAC system?

PREPLANNING FOR THE EMS

Once it has been determined that the building/district is well suited for the installation of an Energy Management System, the district should initiate a study of building/district needs in a more specific process:

1. Conduct an energy audit of the building and identify areas where systems may be made more effective.
2. Tune the building systems so they operatemost efficiently enabling determination of additional savings attributable solely to the EMS.
3. Analyze the electrical loads and peaks to determine the possible savings due to demand limiting and load shedding.
4. Compute an inventory of systems and equip-

ment contemplated for connecting to the energy management system

5. Check alternatives to central control, such as replacing some pneumatic controls with more accurate electronic controls for individual fan systems.
6. Consider whether the energy management system will be for one building only, or whether it is for multiple buildings.

SELECTION OF THE ENERGY MANAGEMENT SYSTEM

When an energy management system has definitely been established as needed and as potentially cost effective, the school district is ready to determine a course of action that will ensure installation of the system best suited to its needs. Goals and scope of the energy management system must be defined. Sources of financing must be considered. A consultant experienced in EMS design and installation should be chosen. Bids will have to be sought, evaluated and selected.

This planning process for the Energy Management System is crucial and should be carefully elaborated. Definite responsibilities should be specified for everyone involved. In this way, the most effective system will be installed and the most savings and benefits can be realized by the district.

The school district will have certain tasks. Bidders also should be expected to perform definite functions. In addition, if possible, a consultant should be used. Whether an in-house expert or a contracted person, this consultant can be of invaluable assistance to the district in the more technical areas of application and knowledge.

The next few pages enumerate possible delineation of the responsibilities to be undertaken in this planning process.

THE SCHOOL DISTRICT'S RESPONSIBILITIES

1. Define goals for the Energy Management System:
   - Reduce consumption
   - Limit electrical demand
   - Monitor alarm systems
   - Improve communications
   - others
2. Define scope of the system:
   - Number of buildings
   - Number of systems
   - Heating and ventilating
   - Lighting
   - Security
   - Fire
   - Communications
   - Others
3. Consider sources of financing:
   - Grants
   - Bonds
   - Shared payback
4. Conduct energy audit, if not already done.
5. Prepare system/equipment inventory, if not already done.
6. Choose a consultant experienced in EMS design and installation.

THE CONSULTANT'S RESPONSIBILITIES

1. Conduct a feasibility study:
   - Cost
   - Savings
   - Payback
2. Plan the design:
   - Front end system control of downstream system control
3. List specifications:
   a. General system specifications of base bid and alternates
   b. Software specifications:
      - Stop/start
      - Analog
      - Duty cycling
      - Demand limiting
      - Optimization programs
      - Analog command
      - User programming
      - Downloading
      - Expansion capabilities
   c. Points list
   d. Itemized cost breakdown for:
      - Parts
      - Installation of hardware
      - Software
      - Documentation
      - Service contracts
4. Participate in bid process:
   - Field checking
   - Pre-bid conference
   - Walk through
   - Evaluation/acceptance of bids
5. Advise in final acceptance of bid

RESPONSIBILITIES OF SCHOOL DISTRICT AND CONSULTANT

1. Detailed equipment inventory
2. Building prints
3. Sequence of operations
4. Special requirements
5. Choosing a vendor:
    - Number of systems in operation
    - Quality of service in area
    - Quality of technicians

RESPONSIBILITIES OF VENDOR

1. Central control hardware/software
2. Installation and checkout
3. Equipment submittals
4. Manuals and software documentation
5. Training
6. Maintenance contract
7. Expansion

OTHER CONSIDERATIONS

There are other considerations in planning for the energy management system. Additional man-hours will be required to operate the system. Personnel will have to be trained in the use of the EMS. A maintenance contract for the central processor, field hardware and transmission system must be made and the cost considered in the EMS payback figures. These additional operating costs will actually be offset by the savings generated with the EMS, but are a hidden factor in considering the payback of the overall operation.

USING THE ENERGY MANAGEMENT SYSTEM

When an energy management system has been put in place, efficient planning will make optimum use of the system.

More than one person should be trained to operate the system in case of emergencies, so that the entire operation is not dependent on a single individual.

DOCUMENTATION

One of the areas that should receive special attention is documentation. Besides rudimentary reference files, such as scale building prints, point locations and wiring diagrams, the following should also be available:

GENERAL DOCUMENTS

- A complete and well-described points list
- Equipment inventory
- System schematics
- Equipment submittals for field hardware
- Manuals and wiring diagrams for the internal wiring of the field panels, and point cards for future in-house maintenance capability

CONSOLE DOCUMENTATION

- Daily log
- Discrepancy log
- Reference manual for each building which should include:
    - Table of contents
    - Complete points list
    - List of field panels and points in each
    - List of systems and points contained in each
    - Sequence of operations
    - List of special conditions and comments
    - Operating manual describing the system in detail and giving explicit procedures for:
        - start up
        - programming
        - normal operation
    - Manual of emergency procedures
    - Maintenance manual for field equipment with a copy in each building.

Specific data should be documented in the operations manual for each building. It takes many man-hours to gather and record all this information. It is recommended, therefore, that books be made up for each building consisting of blank forms that could be filled in as the information becomes available. This should also be done for each new building as it is added to the EMS system, so that documentation can keep pace with any system expansion.

SOFTWARE

When applying any of the software functions, it is important to develop a complete understanding of how the function works. Even a small error may result in an ineffective application. It is also important that the console operator utilize the software functions to the greatest extent possible. Quite often the function for which the software was designed is much too narrow. By using innovative manipulation of the software, it can be expanded to broaden functions and applications.

SELECTION OF POINTS

There must be careful selection of the points to be controlled and monitored:

1. Point selection should be focused on the ON-OFF control of the primary energy systems such as the boilers and main HVAC units. In

addition, there must be some ability to control temperature and ventilation through fresh air damper adjustments and night temperature set-back control.

2. Temperature sensors must be placed strategically within the building so that they may provide the necessary feedback information for effective building operation. Properly selected monitoring points will allow the computer operator to make operational and scheduling decisions based on environmental conditions. In many cases, the computer can be programmed to make operational adjustments automatically if there is sufficient feedback information. In other cases, relatively small number of temperature points in each building may be sufficient to satisfy the operational objectives.

SYSTEM OPERATION

Once a system is installed, it is essential that it be effectively operated in order to extract the greatest amount of the potential energy savings. The operation is most successful, and savings are maximized, when one person is either hired or appointed to operate the system and to work with the individual schools to develop operational schedules that will conform to building activities. That person should also be responsible for dealing with the Energy Management System and energy related problems. While it may be desirable for this person to have an engineering degree, an equivalency may suffice depending on training and HVAC experience. Past studies have shown that this type of position can pay for itself very quickly, especially with a large system.

While feedback of interior temperatures is of prime importance, outside temperature readings are also needed so the computer can adjust to seasonal changes. Controlling heating and air conditioning based on precise temperature input and feedback from the building would be advantageous. During hours when no students are attending classes, or during evening and weekend hours, EMS maintains building and night set-back temperatures only. To override for office and community use or extra-curricular events, the energy manager would request a return to day time operating temperatures only by contacting the EMS operater located on or off the school site. Other functions that can be controlled with indoor/outdoor temperature sensing are:

1. Day/night mode operation
2. Start-time optimization
3. Boiler shutoff
4. Duty-cycling based on temperature

One outside sensor (plus a spare for comparison) and three to five strategically placed temperature points should be sufficient in a building to control most of the desired HVAC functions.

Be sure to specify the software that must support these functions.

PART V—OPERATIONS AND MAINTENANCE FOR ENERGY CONSERVATION

Energy management is a step-by-step process. A successful program begins with the most obvious conservation and those that are lowest in cost should come first. This section describes the role of the operations and maintenance (O&M) audit in identifying specific items or areas within a building where energy is being wasted and describes how an O&M audit can be used to set up a prioritized list of corrections to be made.

The O&M audit is a structured review of all the energy-related aspects of a building. The goal of the audit is to determine ways to provide for minimal operational time while maintaining a comfortable environment. In addition, the audit should identify the maintenance procedures for saving energy and minimizing major repair problems. The O&M audit includes three distinct aspects:

1. Collection of basic information about the buildings in order to provide a database for recommended actions. This basic information should include building size, operating procedures and schedules, structural integrity, and equipment design and condition.
2. A listing and assessment of operating changes or maintenance actions that might improve the building's energy efficiency. Identified changes should be prioritized based on payback, difficulty of implementation, and district policies.
3. A brief assessment of the need for energy conservation measures requiring extensive capital outlays.

PREPARING FOR THE O&M AUDIT

WHERE TO BEGIN

Which buildings should be audited first? The district's developing database should show which buildings use the most energy *per square foot,* and therefore offer the potential for greatest savings. Another approach is to identify the horsepower of the motors driving the building's ventilating fans. The more "fan horsepower" in a building, the more likely the building can benefit from the results of an audit. The newest buildings are also prime targets for consideration because they contain high energy heating, ventilating, and air conditioning (HVAC) systems. It is possible that the more complex the controls, the less likely the system is operating properly; automatic controls that are working *below design standards* is a leading source of energy waste.

ESTABLISHING THE AUDIT TEAM

The audit team should be headed by the Energy Management Officer and should have at least one technical member such as a consultant, a staff engineer, the director of maintenance, or someone from the utility company. The rest of the team might include the principal, head custodian, a teacher and a student. At least one member of the team should have a working knowledge of the building's HVAC systems.

The role of the audit team is to inspect and analyze the district's energy systems and to suggest changes, especially those that can be implemented quickly and at little or no cost—the "Quick Fix."

The team needs the appropriate tools—a light meter, thermometers, flashlights, small-scale building plans, a cassette recorder and notepads.

CONDUCTING THE O&M AUDIT

At the beginning of the audit, the team should spend a few minutes discussing the building in general, using the small scale building plan for an overall review of the building. If it is the first audit for most team members, their role (to question how and why the building's energy systems are operating and make suggestions for possible changes) should be discussed. The team should become familiar with the operating practices of the building. This is also a good time to discuss the building's utilization schedule and characteristic occupants.

The team should be reminded that the audit is a building survey to generate the maximum level of observations and suggestions. The team should be asked to concentrate on modifications in maintenance, operations, and scheduling—whatever can be implemented quickly and at little or no cost. (A review of the "SDEP Energy Awareness Checklist" beginning on page 9 could help update team members on "quick fix" techniques.)

As the team begins the tour, members should concentrate their efforts on the four specific energy saving categories (light-level reduction, ventilation reduction, unoccupied shutdown, and temperature setback) and keep the following questions in mind as they survey:

1. **Occupancy Schedule**
   Can night and weekend uses be consolidated on one night, or into a single wing, or moved into another building?
2. **Lighting Levels**
   Do lighting levels conform to guidelines? Can tubes be removed, circuits added, or more efficient tubes substituted? What are the pros/cons of replacing existing ballasts with electronic ballasts?
3. **Thermostat Settings**
   Do thermostat settings conform to guidelines? Can they be lowered in winter, raised in summer? (Careful attention to thermostats can result in substantial reduction in energy consumption.)
4. **Ventilation**
   Has the amount of outside air been reduced to a minimum? Are there automatic controls to shut off ventilation unless space is occupied? Should exhaust fans be turned on during a portion of night hours to exhaust hot daytime ambient air?
5. **Unoccupied Shutdown**
   Are there automatic controls to turn off unit ventilators and other fan units when the space is unoccupied? If so, are these working and set for a minimum number of operating hours?
6. **Temperature Setback**
   Are there automatic controls designed to change to a night thermostat setting of 50/55 when the building is unoccupied?

Audit Checklist

To help the team consider and record all areas of possible energy waste, an "Operations and Maintenance Audit Checklist" should be completed during the audit. The checklist provides a format to insure that the audit team will cover all relevant aspects of a building which include:

1. Structure (envelope, roof, doors, windows)
2. Heating plant
3. Control system
4. Ventilation system
5. Domestic water system
6. kitchen
7. lighting

(A SDEP sample form of a suggested Operations and Maintenance Audit Checklist is provided in the Appendix.)

Completing the Checklist

When the checklist is completed, the audit team will have a comprehensive picture of the condition of the building structure, how the building's equipment actually operates, and the general level of maintenance. The checklist, therefore, provides the basic data needed for listing and prioritizing recommended energy conservation actions.

After the Audit

Direct Positive Effects

The first O&M audit may not uncover all the possible energy conservation measures, but one thing is certain: mini-audits create awareness and sensitivity to the opportunity to conserve energy. Teachers, custodians, and students learn that the district is serious about reducing energy consumption. They participate on the team, ask questions and offer suggestions.

The O&M Audit Report

When the audit tour is completed, *one person must prepare the report*—usually this is done by the Energy Management Officer or staff engineer. The most important part of the report is a list of operational and/or maintenance changes *to be implemented*. One way of organizing such a list is shown on the following page (the Audit Write-Up).

The audit report becomes the basic energy conservation document for each building and should be complete, detailed and include the completed O&M checklist with the team's recommendations for action. Comments and suggestions can be grouped by major category—HVAC, building construction, operating and maintenance, lighting, and miscellaneous. Each category should list or summarize the audit team's findings and list any suggestions.

The O&M audit should emphasize low or no-cost changes. Only minor attention in the report needs to be given to the amount of energy saved by a particular change. Most of the items identified by the checklist

THE AUDIT WRITE-UP

Building ______________________ Date of Audit ______________________

I. Brief description of the building's HVAC system

II. Brief description of the building structure

III. Brief description of utilities

IV. Observations and recommendations

A. Heating & Ventilating System (ventilation reduction, temperature setback, unoccupied shutdown)

B. Lighting

C. Heat loss and infiltration

D. Boilers and chillers

E. Domestic hot water

F. Other

V. Recommendations: Maintenance and Operation Changes

1.

2.

3.

4.

5.

will save enough energy to quickly offset the minor labor costs involved in implementing them.

IMPLEMENTING O&M AUDIT RECOMMENDATIONS

Copies of the completed report should be distributed to each team member and to the building energy conservation committee. The actual implementation of the recommendations varies with the organization of the district. If, for example, the building principal is responsible for corrective action, he issues work orders for the quick-fix items. A few weeks after the principal receives the O&M audit report, a follow-up visit by the Energy Management Officer is suggested—to answer any questions and to be sure corrective action is underway.

In many cases, recommendations can be implemented without a work order. For example, a custodian familiar with building systems needs only an activities schedule to begin timely shutdowns and setbacks. This same custodian can also make minor systems adjustments. Of course, the Energy Officer should always make a follow-up visit to monitor implementation.

With the initial O&M audit complete and the changes implemented, the Energy Officer and the building committee are now responsible for seeing that all measures continue to be carried out. The reward for this vigilance is the satisfaction one receives through monitoring reduced energy consumption in the building. *But the process does not end here. Continued progress requires follow-up audits to identify the need for renewed and/or additional energy conservation measures.*

PART VI—HVAC CONTROLS

This section addresses the need for energy conservation in heating, ventilation and air conditioning (HVAC). The major components of your HVAC system are the heart of your building's operations. As long as there is adequate heat on cold days or cooling on hot days, very few complaints are heard. If the building is too cold in winter, or too hot in summer, you know the reaction!

In most cases the comfort level is adequate, but many dollars and BTUs are being wasted by inefficient boilers, excessive exhausting of conditioned air, or a large intake of outside air that has to be heated or cooled. Due caution should be exercised when reducing outside air intake to prevent "sick building" syndrome normally caused by poor air quality and inadequate ventilation.

Lack of training and HVAC expertise is a major concern when attemtping to conserve energy. Maintenance and custodial staff do their best to provide a good environment throughout the physical plant, but are often not trained to perform the job that is expected of them. Just as open heart surgery is performed by a surgeon rather than a general practitioner, an efficient HVAC system must be supervised and maintained by a person trained and qualified in that area.

The following pages contain guidelines and procedures that should be put into practice by your professional staff or an outside contractor who has expertise in maintaining or calibrating the equipment. Be sure to specify to the service personnel what is expected of them and the results you want to achieve.

BOILERS

Your boiler is the front end of your heating system. It is critical that this unit be maintained in terms of efficiency and safety. Be sure that any person making repairs or adjustments to the boiler is qualified. Boilers can be very dangerous if personnel are unfamiliar with them. Boilers must be operated only by personnel licensed by the Department of Labor, Office of Boilers, Pressure Vessels and Refrigeration. Don't be afraid of a boiler, but *respect* it!

BURNER EFFICIENCY

Burner efficiency relates to the manner in which your boiler receives, mixes, and properly burns fuel to produce heat. When converting a fuel to heat, there is always a certain amount of loss that cannot be avoided. The goal of tuning a boiler burner is to minimize the amount of heat lost to the atmosphere. You will save approximately two percent of your consumption for every one percent you improve your burner efficiency. Perform a flue gas test at least annually using the following approach:

A. Attain maximum efficiency (82 to 85%)
B. Maintain a stack temperature of 275° to 350°F
C. Be sure the air intake is clean
D. Be sure that linkage is tight

BOILER HEAT TRANSFER

Boiler heat transfer is the method by which the heat produced by the burner is transferred to the medium and circulated to the building's heating units to provide a comfortable environment. To provide effective heat transfer, insulators such as soot and scale in the boiler and system must be held to a minimum. Proper water treatment and general internal boiler maintenance are required to achieve this goal. An 1 1/32 inch of soot will cause an average fuel loss of 2.9 percent! Clean boiler at least annually by performing the following functions:

A. Remove soot from fire side
B. Remove scale from water side
C. Maintain a water treatment program
D. Inspect insulation and repair, if necessary
E. Inspect fire box and repair, if necessary

BOILER CONTROLS

Boiler controls are the means by which your boiler is operated. Many times we find that habit, rather than expertise, are the operational standards. This can lead to excessive and wasteful use of fuels. Set the correct guidelines for boiler operation and control and in-service your boiler operators, if necessary. Operate at lowest temperature or pressure possible:

A. Attain a 20 degree differential between ON/OFF cycles

B. Do not operate hot water boilers below 140° degrees F
C. Maintain operation on low fire, if possible
D. Operate boilers on lead/lac system

Operate only the units required:
A. Do not fire a standby unless it is in ready mode, and necessary.
B. Operate the most efficient unit for main heating.
C. Keep boiler off whenever possible, as in mild weather.
D. Use automatic outside air controls for positive shutdown at a specified temperature setting.

BOILER SAFETY

Boiler safety has a direct relationship with energy conservation. Many of the items to be checked regularly for safety will also alert your staff to potential inefficiency problems with the burner or heat transfer. In addition, the school must maintain a safe environment. Documentation (of inspections, maintenance, major service, etc.) is a very important factor if a problem is incurred. Maintain a boiler log sheet:
A. ON/OFF times in mild weather
B. Date water treatment was checked
C. Date safety relief was checked
D. Date low water cut-off was checked
E. Date of flame failure test
F. Date of repairs, malfunctions, etc.
G. Date of boiler blow-down and length of time taken

Items to be inspected:
A. Flame failure test—monthly
B. Low water cut-off test
  a. Hot water systems—monthly
  b. Steam systems—variable (daily through weekly)
C. Water-treatment testing
  a. Hot water—monthly
  b. Steam systems—weekly

Combustion air intake:
A. *Do not* close off outside air intake.
B. Keep leaves, lint and dirt off intake grill.
C. Install automatic dampers, if possible.

Maintenance or Repair:
A. Use qualified staff or a licensed contractor.
B. Check local and state codes before modifying the controls or piping.
C. Repairs or maintenance should be accomplished when students are *not* present in the building.
D. Never push a reset button more than twice—determine the problem.
E. Be sure all water valves are appropriately open or closed.

MAIN HEATING LOOP

The Main Heating Loop is the portion of the system that supplies and returns the heating medium to and from your heating units. Controlling the supply temperature in this system will provide a comfort zone and minimize the overheating or under heating of the building. Maintaining this portion of your total system is very important, especially when steam is your heating source.

HOT WATER SYSTEMS:

A. A three-way valve and outside air temperature reset control should be in place and operable for optimum control.
B. Supply and return temperatures should be monitored to ensure that heating units are utilizing the heat produced.
C. Only the necessary circulating pump should be operated and alternated for even wear and operation.
D. Downstream control valves should be functional-checked regularly to ensure proper operation.
E. All heating lines, supply, return,elbows, flanges, etc. should be properly insulated to reduce heat loss.
F. Expansion tanks should be checked for water logging. A level of 1/2 to 3/4, with an adequate air cushion, should be maintained.
G. Supply and return pressure should be monitored daily to ensure proper flow.

STEAM SYSTEMS:

A. Ensure that all main hand valves are fully open when operating
B. Inspect all steam traps at least annually:
  a. Main line drip traps must be in operational condition to prevent starvation of heat to heating units
  b. Individual unit traps must be in operational condition, or overheating will occur in the area serviced
C. Defective traps will return raw steam to the return system and cause heat loss and condensate pump failures
D. Inspect all condensate return pumps regularly to ensure proper operation and inspect for leakage.

E. If your building has had several additions, be sure that the condensate return storage is adequate and that hot water is not being discharged to a drain.

F. All supply lines should be insulated except return lines. High return temperatures (i.e., over 210° degrees F) will cause seal failure on return pumps.

G. Strainer drip legs should be opened weekly to eliminate build-up of solids.

PNEUMATIC AND ELECTRIC CONTROLS

Most schools are equipped with either pneumatic (air powered) or electric temperatre control systems. These systems provide a means of signaling equipment, sensors, relays, etc. of what they should or should not do. If any of the controls are out of calibration or synchronization on front end or downstream equipment, your system or units cannot operate in an efficient or effective manner.

AIR COMPRESSOR OPERATION AND MAINTENANCE:

A. Operate the air compressor at the lowest possible pressure settings that will maintain adequate pressure at all controls, i.e., 40 psi ON, 60 psi OFF. Always maintain at least 20 psi differential.

B. Keep the tank free of condensate; drain regularly, depending on moisture build-up.

C. Keep drive belts properly adjusted.

D. Keep the intake air filter clean.

E. Keep the condenser clean if a refrigerated conditioner is used on the system.

F. Check the safety relief valve regularly.

G. Repair minor air or oil leaks to prevent major problems.

H. Clean oil and water separators on a regular basis to ensure proper operation of peripheral controls.

PRESSURE REGULATOR VALVE:

A. Calibrate air gauge to ensure accuracy.

B. Check regulator adjustment to ensure adequate line pressure for day and night controls.

PNEUMATIC CONTROLS:

A. Inspect regularly for air leaks, oil seepage, water in controls, loose linkage, damaged or broken components, etc.

B. Functional—check the controller to ensure that it is operable.

C. Calibrate controllers for optimum performance. Calibration should be performed by a competent controls person from your staff or by a private contractor.

D. Keep gauges and temperature sensors in good repair and calibration so they can be utilized to monitor operation of the unit or system.

ELECTRIC CONTROL:

A. Clean all electric controls regularly to ensure proper sensing of the unit

B. Functional-check electric contacts to ensure proper operation

C. Inspect and tighten all electrical connections to reduce electrical draw

DAY/NIGHT SETBACK SYSTEM:

A. Locate and label all night thermostats.

B. Recommended setting for night thermostats is 55 degrees, however this may depend upon facility location and other factors.

C. Program the time clock to correspond to curriculum hours with a minimal warm-up cycle and a maximum cool-down cycle.

D. If day cycle is needed for evening activities, install additional ON/OFF pins to produce an intermittent warm-up cycle (approximately two hours).

E. Twist-timer overrides can also be used for after-hours control of heating or cooling systems.

F. Monitor rooms or zones under night control to ensure that the system is operating properly and maintaining night temperatures determined by thermostat setting.

G. Inspect outside air dampers to ensure that they are tightly closed during the night cycle.

H. Inspect time clocks on a regular schedule to ensure proper calibration of clock, day cycle, night cycle, and weekend cycle. The building should also be operated on night cycle for vacations, holidays and snow days.

AIR CONDITIONING

Air conditioning is approximately three times more expensive to operate than heating. It is necessary to operate and maintain your systems at maximum efficiency for adequate cooling and still conserve energy. Most people would prefer to have temperatures of 75° in winter, but prefer 68°–70° in summer. Why? How about short sleeves in the summer and sweaters in the winter, and reverse those temperature settings! Here are some basic rules for air conditioning:

1. Thermostats should be set to cool a space no lower than 75 degrees for day and 85 degrees for night in critical conditioned spaces. General areas should not be cooled at night, just ventilated with outside air.
2. Areas that have minimal or no occupancy should not be cooled.
3. Filters should be cleaned or replaced regularly to ensure maximum operating efficiency.
4. Economizer controls should be used to reduce compressor operation and take advantage of free cooling with outside air when possible .
5. Outside air lockout controls should be used to ensure shutdown of air conditioning units at a predetermined temperature.
6. Compressors should be staged to allow only the units needed to operate.
7. Window air conditioners should be covered in winter to prevent air infiltration.

EXHAUST FANS

Exhaust fans are a source of large heat loss from a building. Fans are needed in some cases to remove odors, fumes, moisture, or excessive heat from a particular area. They are in place to be used if needed. Thousands of dollars of conditioned air are exhausted needlessly, due to lack of control. In-service staff and students to use these units only if necessary and energy will be saved.

Some ideas to follow:

1. Evaluate the need for all exhaust fans; eliminate or reduce their operational hours whenever possible. This should be done by a licensed mechanical engineer.
2. Inspect all exhaust fans for proper operation of back draft dampers to reduce air infiltration and heat loss.
3. Provide for effective exhaust fan control by installing twist timers, clock timers, keyed switches, etc.
4. Keep motors, fan blades and air grills free of dirt to reduce energy usage and extend useful life.
5. Exhaust fans should be OFF during unoccupied hours.
6. For proper control, all exhaust fans should be identified as to:
   - Area served
   - ON/OFF control points.

The fans should then be labeled. This information should also be drawn on a building schematic and posted for custodial and maintenance staff.

PART VII—THE CUSTODIAN AND ENERGY CONSERVATION

A TEAM EFFORT

Effective energy conservation must be a team effort. The custodial staff is a very important part of that team. Custodians are chief among the important people who keep our buildings sufficiently lighted, adequately cleaned, heated and air conditioned. They spend many hours maintaining and caring for the physical plant. If they are energy conscious, they can do much to make a significant difference in energy consumption.

This section of the manual offers some practical suggestions for energy conservation that can be implemented by the custodial staff. Many of the suggestions require only heightened vigilance and attention to detail. Others involve minor repairs or adjustments. In the long run, actions like these make a significant contribution to the district's overall energy conservation effort.

WHAT CAN A CUSTODIAN DO?

Quick fix energy saving measures are changes that can be made quickly at little or no cost. Operating and maintenance staffs can usually accomplish these measures without assistance and at minimal labor and equipment expense.

Quick fix opportunities exist in all energy using areas. There are "quick-fix" opportunities in lighting, heating, air conditioning, ventilation and water systems. The custodial staff should be aware of the possibilities for "quick-fix" in each of these areas. They should implement as many "quick-fix" opportunities as possible, and should be encouraged to identify and make suggestions for implementing other more complex energy-saving options.

The custodian's length of employment or lack of technical knowledge shouldn't exclude that person from "quick-fix" measures. Those who do have technical knowledge of operational equipment can always use help in making and maintaining "quick-fix" adjustments; and, they need to be kept informed of obvious malfunctions.

In addition to assisting with implementation of "quick-fix" changes, custodians can play a valuable role in the data collection program. Custodians can be asked to read the gas and electric meters on a regular schedule. (See the Data Collection section for more details.) This serves two functions. It provides on site expertise in data collection and monitoring, and it also serves to motivate custodial participation in the district's overall energy conservation program.

Another role for the custodian to play in the School District Energy Program is serving as a member of the building audit team. The head custodian should always be included on the team when an audit is conducted in his/her building. Not only will the custodian learn about the conservation effort, but also may be one of the most knowledgeable team members relative to actual operation of the building.

The extent of custodial involvement in the energy conservation program will be dependent on the district's organization for custodial and maintenance services; i.e., are custodians involved in routine maintenance or are they simply cleaners? The sophistication of the custodial staff will also be a factor.

If custodians are responsible for basic building operations and routine maintenance, they should be provided with the Energy Awareness Checklist (beginning on page 9). Even if the district's custodians are not involved in building operations and maintenance, they should be encouraged to be energy conscious members of the district team. They should be made aware of the district's energy conservation goals and should be encouraged to practice energy conservation on the job.

Below is a SDEP sample form, *Awareness Audit for Custodial Staff.* This form can be distributed to custodians as a tool they can use to increase their participation in the energy conservation program. As an addition to an in-service program, the Awareness Audit can help custodians become aware of potential energy saving actions and recruit them in becoming active members of the energy conservation team.

AWARENESS AUDIT FOR CUSTODIAL STAFF

Energy conservation demands constant attention. Variations can make a big difference in the amount of energy a building uses, and it's important to watch for energy-wasters all the time. You are in the building every day, and while you are there you can use all your senses to find ways to save energy. Make sure you look, feel and listen for energy wasters. Check the list below each day to ensure that your building is energy efficient.

WATCH FOR LIGHT SAVINGS

- Do some rooms seem too bright?
- Are fixtures dirty?
- Are you using high wattage incandescent bulbs?
- Are multiple switches labeled?
- Are decorative lighting or lighted display cases needed?
- Are parking lot lights on at dusk and off at dawn?
- Do you turn lights on at dusk and off at dawn?
- Do you turn lights off after leaving a room? Does everyone else?

BE AWARE OF TEMPERATURE LEVELS

- Are thermostats set at the districts recommended levels?
- Are thermostats working?
- Is water running out of thermostats or are they bleeding air excessively?
- Are unit vents on low speed and off in mild weather?
- Are some rooms too hot? too cold?
- When does the building start to warm up? Does it seem to do so too early?
- When does the building start to cool off for the night? Does it seem too late?
- Are separate parts of a building heated for after hour activities? Should one area be used and only part of the building heated?

WHAT ABOUT INFILTRATION?

- Do you feel drafts?
- Is the window air conditioner covered in winter?
- Is there weatherstripping on doors and windows?
- Are door closures working properly?
- If there are vestibule doors, are they used?
- Are there any structural cracks? (Be sure to check above ceilings)
- Do loading dock doors fit tightly?
- Are blinds and drapes closed at night and on windy days?

WATCH AND LISTEN FOR EQUIPMENT RUNNING

- If it's running, is it needed?
- Should it be on? (Fans, typewriters, coffee pots,vending machines, copy machines)

BE AWARE OF LEAKS

- Are there any hot water, steam or domestic water leaks?
- Do urinals run all the time?

CHECK THE INSULATION

- Are pipes insulated?
- Is insulation in good condition?

MISCELLANEOUS

- Is the incinerator fired only to start burning?
- Are exhaust fans running continually?
- Are filters and fin tubes clean?

LOOK, LISTEN AND FEEL! If you notice things are wasting energy, make a change or report the need for a change to the appropriate person. Remember, you can have a real impact on the energy program.

PART VIII—PREVENTIVE MAINTENANCE

Preventive Maintenance (PM) is an *organized and planned program to keep all components of the physical plant in peak operating condition.* Wear and tear on buildings and equipment inevitably lead to changes in operating efficiency. A PM program ensures that continuous and periodic measures are taken to minimize deterioration of the physical plant and to maintain maximum operating efficiency.

Preventive Maintenance requires a fair investment in the beginning—in time, in expense for instrumentation, and in additional staff or reassignment of existing staff. If a school board accepts and agrees with these investments, a preventive maintenance program can be established that will save money for the district in the following five ways:

1. PM can extend equipment life by periodic inspection, lubrication and adjustment.
2. PM can identify small problems before they become major problems and reduce equipment downtime.
3. PM can help avoid costly emergency repairs.
4. PM can reduce overtime as the result of a balanced workload and scheduled equipment maintenance.
5. PM can ensure safe, quiet, efficient operation of equipment.

The value of a good PM program is twofold. Traditionally, preventive maintenance has been viewed as a way of extending equipment life and reducing costly emergency breakdowns. It will do that. *But a good PM program can also help reduce energy consumption.* Properly adjusted and maintained equipment will operate much more efficiently than equipment receiving little or no maintenance, and, more efficient equipment operation means reduced energy consumption.

The next section explores how a successful PM program can be designed and implemented.

DESIGNING AND IMPLEMENTING THE PM COMPONENTS

There are seven basic issues that should always be utilized in designing and implementing a successful PM component.

1. **Planning the System**
   The maintenance, custodial and administrative staffs should be involved in designing the PM program. This will help ensure acceptance of the program, since these groups must be involved to insure successful implementation.
2. **Setting Priorities**
   The PM program should establish priorities for maintenance. Critical and high energy-consuming equipment should be put on the PM system first. Other equipment can be added later.
3. **Analyzing Existing Maintenance**
   Before setting its goals, a district should begin looking at a PM design that will make the most efficient use of existing procedures and employee skills. The district should analyze its current maintenance as follows:
   a. Review the level and frequency of maintenance currently being performed.
   b. Identify the areas of high maintenance.
   c. Identify personnel currently maintaining the equipment.
   d. Determine whether or not present employees can be trained to perform more maintenance.
   e. Decide whether or not the existing work order system can be used for PM, or if a new system should be designed.
   f. Consider whether or not the PM program should be manual or computerized.
4. **Organizing the Staff**
   The maintenance staff should be organized into two divisions, one responsible for repairs and the other for preventive maintenance. Unless such a division is created, repairs will take priority and preventive maintenance will not be performed regularly. Regardless of how large or how small the staff, certain individuals should be assigned preventive maintenance as their primary responsibility.
5. **Simplifying the Paperwork**
   The PM program designed should be simple to operate and involve a minimum of paperwork. Whether or not the PM program is computerized, it must be "user-friendly."

6. Implementing the PM Program

Once the goals are set, current maintenance procedures analyzed, and a program designed, a district is ready to implement its new preventive maintenance program. PM implementation should involve the following basic steps:

a. Inventorying equipment and building components.
b. Establishing basic maintenance tasks.
c. Prioritizing task and identifying manpower skills.
d. Scheduling PM tasks.
e. Developing a work order system.
f. Monitoring PM performance.

Each of these steps will be discussed in some detail on the following pages.

7. Inventory of Equipment and Building Components

High energy consuming and critical mechanical and electrical equipment should receive top priority as inventory is started. Less critical equipment can be inventoried later after PM is successfully underway.

The suggested SDEP sample forms, the *Preventive Maintenance Inventory,* on the following pages can be used to gather basic data about equipment. The forms are designed to answer the following questions:

- What is it?
- Where is it?
- How many are there?

This information should be collected for each piece of equipment to be included in the PM program.

One easy way to do a PM inventory is to use a tape recorder on building tours to record verbal comments on each piece of equipment. The data can then be transferred to the forms.

PREVENTIVE MAINTENANCE INVENTORY

Date______________

BUILDING NAME:	BUILDING NO.:	
PLUMBING EQUIPMENT	No. of Each	Remarks
Drinking Fountains		
Water Closets		
Lavatories		
Urinals		
Showers		
Kitchen Sinks		
Service Sinks		
Mechanical Rooms		
Floor Drains		
Safety		
Showers		
Outside Sillcocks		
Other		
MISCELLANEOUS EQUIPMENT	No. of Each	Remarks
Motor Starters		
Pressure Switches		
Other		
DOORS	No. of Each	Remarks
Overhead Doors		
Exterior Doors		

PREVENTIVE MAINTENANCE INVENTORY

Date________________

BUILDING NAME: BUILDING NO.:

Thermostat Locations: Include room number and quantity

MECHANICAL EQUIPMENT ELECTRICAL MOTOR PREVENTIVE MAINTENANCE INVENTORY

BUILDING NAME BUILDING NO.

Equipment Name & No.
Location
Manufacturer
Model No. (Size, type) Serial No.
Type of Bearing Lube (Grease) (Oil) (Sealed)
Other
Motor Manufacturer Horsepower
Motor Model No. Frame No.
Type of Bearing Lube (Grease) (Oil) (Sealed)
Motor Starter (Yes) (No)
Other

Equipment Name & No.
Location
Manufacturer
Model No. (Size, type) Serial No.
Type of Bearing Lube (Grease) (Oil) (Sealed)
Other
Motor Manufacturer Horsepower
Motor Model No. Frame No.
Type of Bearing Lube (Grease) (Oil) (Sealed)
Motor Starter (Yes) (No)
Other

Equipment Name & No.
Location
Manufacturer
Model No. (Size, type) Serial No.
Type of Bearing Lube (Grease) (Oil) (Sealed)
Other
Motor Manufacturer Horsepower
Motor Model No. Frame No.
Type of Bearing Lube (Grease) (Oil) (Sealed)
Motor Starter (Yes) (No)
Other

Equipment Name & No.
Location
Manufacturer
Model No. (Size, type) Serial No.
Type of Bearing Lube (Grease) (Oil) (Sealed)
Other
Motor Manufacturer Horsepower
Motor Model No. Frame No.
Type of Bearing Lube (Grease) (Oil) (Sealed)
Motor Starter (Yes) (No)
Other

DATE

ESTABLISHING BASIC MAINTENANCE TASKS

Different equipment requires different kinds of maintenance. However, there are six basic tasks or checks that are required to maintain most pieces of equipment:

1. **Visual Check**
   PM personnel should visually check major equipment daily to spot obvious problems.
2. **Cleaning**
   Scheduled cleaning of mechanical equipment is an important part of a PM program. PM personnel should check for oil, dirt and rust. Dirty equipment leads to increased breakdown and can mask critical problems.
3. **Functional Check**
   PM personnel should routinely inspect equipment for proper and efficient operation. A suggested list of functional checks has been developed for each major equipment type. Functional checks are a top priority and the heart of a PM program. They are usually performed by skilled maintenance staff.
4. **Lubrication**
   PM personnel should keep the moving parts greased and oiled on a regular schedule.
5. **Service**
   Some pieces of equipment require regularly scheduled adjustments. Such a service schedule should be incorporated into the PM program.
6. **Vibration Check**
   PM personnel should routinely inspect and record vibration levels using a vibration meter.

See the suggested form below, ***Preventive Maintenance Procedures,*** for an example of the preventive maintenance procedures included in the six categories just mentioned. The sample outlines the PM procedures for maintaining pumps. SDEP has developed PM procedure sheets for boilers, pumps, air compressors, fans, thermostats and non-mechanical equipment (plumbing, doors, etc.).

PREVENTIVE MAINTENANCE PROCEDURES FOR PUMPS

1. **Visual Check** (Head Custodian)
   Brief, daily inspection to include:
   - Check for changes in noise, vibration, overheating of pump or motor.
   - Check for leaks.
   - Each week manually rotate pumps shut down for the season.
2. **Clean** (Custodial)
   Keep equipment clean; keep free of oil, dirt, mineral deposits, rust, etc., as necessary.
3. **Functional Check** (Skilled Maintenance)
   - Check oil level.
   - Start pump if not running (in season only).
   - Check for unusual noise, vibration, overheating.
   - Check for leaks.
   - Check gauge readings (pressure, temperature).
   - Check for correct rotation.
   - Check water level controls.
   - Check alternator for proper operation.
   - Check coupling and align if needed.
   - Check seals and replace if needed.
   - Check packing and repack if needed.
   - Replace rubber motor mounts if needed.
   - Check and clean strainers.
   - Replace leaking check valves.
   - Check sump pump pit for sludge and flush.
   - Tighten loose bolts and connections.
4. **Lubricate** (Skilled Maintenance)
   - Change oil and clean oil reservoir on pumps with drain plug.
   - Add oil to wick-lubricated pumps and replace wick if needed.
   - Grease pumps and motors with grease fittings.
   - Oil motors with oil cups.
   - Clean, wipe down pump and motor.
5. **Vibration Check** (Skilled Maintenance)
   - Using a vibration meter, take readings and record.

PRIORITIZING TASKS AND IDENTIFYING MANPOWER SKILLS

PM PRIORITIES

The PM program should establish priorities for maintenance tasks. Critical and high energy-consuming equipment should be the highest PM priority (PRIORITY #1) with other less critical equipment receiving lower PM priorities. Functional checks on critical equipment should have the highest priority since neglect of these checks could lead to major breakdowns that might affect keeping the school open or cause larger repair bills.

PM MANPOWER SKILLS

The PM Supervisor should decide at what skill level each staff member is capable of performing. This decision determines who should do what. ***(Note: Skill Level 3 is the highest skill level.)***

(Skill Level 3)
Maintenance personnel—usually does functional check, lube, service, and vibration check of equipment.

(Skill Level 2)
Depending on abilities, the *Head Custodian* usually does visual check, functional check, lube, and service of less complex equipment.

(Skill Level 1)
Custodian—usually does cleaning tasks, but in some cases, may do functional check and lube of less complex equipment.

MATCHING PRIORITIES AND SKILLS

At this point in the PM program, equipment maintenance procedures and personnel skill levels need to be matched. This is a very critical step and should be the responsibility of the PM Supervisor. In general, high priority tasks such as functional checks of major equipment are assigned to Skill Level 3 personnel with lower priority tasks such as lubrication and belt changing being assigned to less skilled personnel. However, the PM Supervisor needs to take into account the unique capabilities of each staff member. In some cases, a head custodian may be very competent and can be assigned some Priority 1 tasks.

KNOW YOUR STAFF

SCHEDULING PM TASKS

When the inventory has been completed and PM procedures and appropriate personnel and skill levels have been identified, it is time to begin scheduling PM tasks. A sample PM scheduling system that has been successfully implemented in several school districts is provided. The system is designed to be simple to implement and operate. Remember, forms and procedures should be modified to meet your specific district's needs.

USING THE PM SCHEDULE SHEET

The suggested sample form, *Preventive Maintenance Schedule Sheet*, on page 54, is designed to be used with major equipment types corresponding to the PM procedures sheets. For example, all the hot water heating pumps in a building should be listed on a single PM Schedule Sheet and the frequency and timing of the various tasks and checks should be indicated.

The completed sample PM Schedule Sheet on the next page may help to explain the process. The completed sample indicates there are two hot water heating pumps (identified from the inventory) requiring PM and that they should all receive a functional check in May and November. They have developed suggested frequency and timing for the major equipment types and this information can be provided upon request.

SKILL LEVELS

In addition, the PM Maintenance Schedule Sheet includes information on the level of skill required for each task and an estimate of the person hours required to complete each task. It is obvious from the completed sample that the functional check of pumps should be done by highly skilled personnel, and that functional checks in the sample building could be expected to take 2.0 person hours.

The lines at the bottom of the form provide space to summarize anticipated person hours needed for PM of hot water heating pumps in the sample building. In the example shown, a total of 5.2 hours is planned, (.4) by Skill Level I personnel, (2.0) by Skill Level 2 personnel, and (2.8) by Skill Level 3 personnel.

PREVENTIVE MAINTENANCE SCHEDULE SHEET

Building________________________________ Equipment Type____________________

PM Procedures	MAINTENANCE FREQUENCY														SKILL LEVEL	TOTAL ANNUAL HOURS
	Month Due															
	Daily	Weekly	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec		
Visual Check																
Clean																
Functional Check																
Lubrication																
Service																
Vibration Check																
Other:																
No. and Location Of:																
Total Level 1																
Total Level 2																
Total Level 3																
Grand Total																

PREVENTIVE MAINTENANCE SCHEDULE SHEET

Building: Energy Elementary

Equipment Type: Pumps-Hot Water Heating

PM Procedures	MAINTENANCE FREQUENCY														SKILL LEVEL	TOTAL ANNUAL HOURS
	Month Due															
	Daily	Weekly	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec		
Visual Check	X														2	2
Clean								X							1	.4
Functional Check							X						X		3	2
Lubrication							X						X		3	.4
Service																
Vibration Check															3	.4
Other:																
No. and Location of:																
2 in Boiler Room																
Total Level 1																.4
Total Level 2																2.0
Total Level 3																2.8
Grand Total																5.2

USING THE PM SCHEDULING CARD

The next step in the scheduling process is to complete a *Preventive Maintenance Scheduling Card* for each piece of equipment to be placed on the PM program. (See sample form on the following page.) Information to complete this card comes from the inventory sheets and the PM Schedule Sheet. A card should be filled out for each piece of equipment, since the completed cards can be used to generate work orders and to keep equipment-specific maintenance records. Once the PM Maintenance Scheduling Cards have been completed they can be placed in a master file that has monthly dividers. For example, if the PM program is to begin in October, all the cards that have a maintenance function listed for October should be filed in that month. The remaining cards should be filed in the first succeeding month for which they have a maintenance function scheduled.

PREVENTIVE MAINTENANCE SCHEDULING CARD

Building	**Equipment Name/Number**												**Location**			
	Month Due and Level of Mechanic															
Main Functions	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Freq	Level	Freq	Level
Visual Check																
Clean																
Functional Check																
Lube																
Service																
Vibration Check																
Date Scheduled																
Date Completed																
Date Scheduled																
Date Completed																
Date Scheduled																
Date Completed																
Date Scheduled																
Date Completed																
Date Scheduled																
Date Completed																
Date Scheduled																
Date Completed																

PM WORK ORDER

Building Name	Date Due	Level	Name	Date Completed				
Equip Name/No.	Location	Clean	Funct Chk	Lube	Service	Vib Chk	Other	Hours

DEVELOPING A WORK ORDER SYSTEM

PM work orders are generated from the master PM Maintenance Scheduling Card file on a monthly basis.

Most districts already have an existing work order system, and the PM work order should be integrated into the existing system. A suggested sample form, ***PM Work Order***, is shown at right.

OPTIONAL WORK AND TROUBLE REPORT SYSTEM

PM personnel could use another simple form to report problems encountered while performing other PM tasks. The *Work and Trouble Report* (see sample form below) can be carried by all PM staff and filled out as they spot problems that are not part of the regular PM program. In a large district, where there is a big PM staff and much equipment, the *Work and Trouble Report* can be useful in identifying and keeping track of needed maintenance tasks that are not part of the PM program.

Monthly, the PM Supervisor should generate a work order from each of the PM Scheduling Cards in the monthly master file. The PM cards should then be refiled under the next month for which a maintenance function is indicated. A copy of the work orders should be distributed to the proper maintenance personnel and a copy should be filed.

When the PM task is finished, the responsible staff person should return the completed work order and the office copy should be removed from the file. If this is done on a regular basis, a quick review of the office work order copies will show which PM tasks have been completed and which ones are still outstanding.

This PM work order system is simple to operate and effective in terms of managing and monitoring performance of PM tasks and in determining costs. Combined with a properly motivated staff, the PM work order system can improve manpower efficiency and substantially reduce expensive emergencies from equipment breakdowns.

MONITORING PM PERFORMANCE

Once the PM program is designed, developed and implemented, it should be evaluated and reviewed for performance and modifications.

MONTHLY REPORTS

The PM Supervisor should prepare a basic monthly re-

WORK AND TROUBLE REPORT				
Problem or Request	Building	Room	Date	
	Name	Phone		
ACTION TAKEN				
Name	Hours	Equipment Name/No.	Date Completed	Job/ Acct. No.
Action Taken				

port of the total PM hours completed for each building and the skill level totals of PM personnel. (See suggested sample form, ***PM Hours Completed,*** on page 61.)

From this data, the supervisor can determine an annual total of PM hours which can be used to demonstrate cost benefits of preventive maintenance.

PM BACKLOG

The assigned PM tasks not completed during any month should also be reported by building, equipment number and function. The backlog report should also include the estimated hours remaining in order to finish the preventive maintenance and the hours already spent on the task. (See suggested sample form, ***Backlog PM Work Orders,*** on page 62.)

This backlog report should be carefully cross-checked by the supervisor to make certain that no critical equipment is being backlogged for PM.

CUSTODIAL INSPECTION LIST FOR PM

The head custodian is the most important person when it comes to keeping a school building operating well. The custodian is there every day and often knows more about the things that go on in a given school building than anyone else. The custodian is the one who goes into the boiler room every day and should be the first one to notice any changes that might mean trouble. If a car doesn't sound "normal" one morning, the owner checks it out. The head custodian should be doing the same thing with the motors, fans and pumps in the building.

The list shown below, the Custodial Inspection List, can be used to help make sure the head custodian checks out the important places in the building on a regular basis. If the head custodian does the things suggested on the list, the building will work better and equipment will last longer.

CUSTODIAL INSPECTION LIST

DAILY

One of the most important things you can do is look, listen, smell, and feel your building every day. Your senses can tell you if something is "not right" and give you clues about trouble areas. Every day, you should perform the following functions:

1. Observe stack vapor when approaching building.
2. Check the boiler by:
   a. Checking the water level in the sight glass.
   b. Checking steam pressure/water temperature.
   c. Looking at the burner flame and combustion dampers.
   d. Checking the operation of the hot water heating pumps.
   e. Draining the water from the air compressor tank and filter element drain bowl.
   f. Scanning valves, piping, tanks and traps for leaks.
3. Tour all mechanical rooms and visually check equipment (pumps, fans, air compressors, water heaters).
4. Observe kitchen and food storage rooms, cooler, freezer temperatures, oven pilots, exhaust fans.
5. Check known problem areas.
6. Check all windows for damage.

WEEKLY

Once a week, take time to check the following:

Equipment rooms/tunnels/attics

1. Inspect all pipes, hangers, valves, and traps.
2. Fill floor drains with water and check for operation.
3. Inspect fans, ductwork, dampers, air filters and coils.

Classrooms and corridors

1. Check temperatures and thermostats. Observe doors, windows and lights for condition and operation.

On the roof

Except during some winter weeks, when it is difficult, you should go up on the roof and inspect the equipment there. You should:

1. Check the roof for debris and remove it.
2. Check and clean all the drains.
3. Observe the roof surface and report any problem areas and/or leaks.
4. Look at all the roof-top equipment to check for unusual noise, vibration or overheating.
5. Notice what equipment is running and if it needs to be in operation.

SPECIAL CAUTION: Be careful when you are on the roof—it is easy to damage the surface.

REMEMBER:

1. Walk on walkways when possible.
2. Don't step on blisters, ridges, expansion joints weak spots.

PREVENTIVE MAINTENANCE HOURS COMPLETED

Building	Month/Year	Level			Total
		1	2	3	

BACKLOG PM WORK ORDERS

Month____________________Year____________________________

Building	Equipment Name/No.	Location from	Clean	Funct Check	Lube	Service	Vib.	Est. Hrs.	Date Comp.	Name	Actual Hrs.

3. Don't drop anything on the roof—you might puncture it.

Monthly

Check air-cooled refrigeration units for dirty condensers and clean if needed.

Three Times a Year (During Vacations)

Three times a year you should schedule time to clean the condensers on all air-cooled refrigeration units. The condensers in window air conditioners, refrigerators, freezers, milk coolers and serving-line refrigeration units should be cleaned at this time.

Annually

All finned radiation tubes should be cleaned once a year.

Swimming Pools

Swimming pools require special attention. If there is one in your building you should follow the checklist below to make sure it is properly maintained.

Daily

Pool Deck

1. (Night Custodian) Check for foreign objects in water and for proper skimming.
2. (Head Custodian) Check the water level and the air and water temperatures.

Pool Pump Equipment Room

1. Check for leaks in pipes, valves and tanks.
2. Check holding tank level and float operation.
3. Check chemical pumps/tank levels.
4. Check recirculating pumps.
5. Take daily readings of strantrol for the health department report. Adjust the feed rates if necessary.
6. Check exhaust and supply fans for proper operation and ventilation.

Weekly

1. Inspect the pool deck, tile, ladders, diving board and pool seating.
2. Inspect piping, pool walls and windows in the pool tunnels.
3. Inspect the holding tank and float valve.
4. Operate the sump pumps.
5. Clean and pre-coat the filter at manufacturer's recommended vacuum gauge reading.
6. Alternate the recirculating pumps.
7. Clean the pool with the water vacuum system. (Night Custodian)
8. Check the strantrol probe cleaner tank.

Annually

Clean, inspect and paint all the exposed metal in the pool tunnel and equipment room. Replace all corroded pipe and conduit. Caulk/seal all leaks on the pool deck and around diving board legs.

Two-Three Years

Drain the pool, perform major cleaning and inspect and regrout as required.

Skilled Maintenance Inspection List

Twice Weekly

If you have a steam boiler, test the water and add chemicals regularly.

Weekly

You should make sure that once a week you take time to check out the following:

Boiler Room

1. With the burner operating, open the drain valve and check the operation of the low water cut-off and feed water column.
2. Operate the relief valve (steam boiler only).
3. Inspect the boiler shell, hand holes and headers.
4. Inspect all pipes, hangers, valves and traps.
5. Manually operate the burner and check the blower, dampers and linkage.
6. Clean the flame sensor and check the control unit.
7. Check/clean the combustion air inlet.
8. Inspect the breeching and check the stack temperature.
9. Check the oil level, drain valve, filter element, air dryer and belt tension on the air compressor.
10. Check the temperatures, control valve, relief valve and circulation pump on the water heater.

Monthly

If you have small steam boilers, test the water and add chemicals. If you have hot water boilers, test the water and add chemicals.

Annually

Once every year, the boiler should be opened, inspected and cleaned per the manufacturer's or insurance company's instructions.

PART IX—ROLE OF THE TEACHER

THE PROBLEM FACING EDUCATORS

The cost of energy came to the forefront in 1974-75 with the advent of the Organization of Petroleum Exporting Countries and will continue to be a problem for school districts for some time to come. In many cases, as much as 75 percent of a district's budget is locked into the fixed costs of salaries and fringe benefits; all other district costs share the remaining funds. In 1992, it was estimated that energy consumed 12 percent of these discretionary monies within an average school district in New Jersey. This percentage is increasing constantly reducing the amount available for other items.

ALTERNATIVES

What are the alternatives? There appear to be only two immediate possibilities:

- conservation
- increased taxes

To the general public, increased taxes are very undesirable—even taboo—and sometimes add to public discontent and nonsupport of district needs.Therefore, conservation appears to be the only realistic approach.

AN OPPORTUNITY TO ADDRESS ENERGY AND VALUES

Educators have a responsibility to students to alert them to the problems identified with energy supplies, the impact of these problems on their lives both at work and at home, and the effect of all this on mobility and economics in their future. Many economists have said that the shortage and cost of energy will influence our lifestyles as we know them. Our young people need to know that energy is expensive and that the costs of energy will continue to escalate until a new source of energy becomes available in large supply or quantity. They must realize that we can continue to be mobile only as long as we can afford to pay the price of energy as charged by the suppliers.

ENERGY CONSERVATION: A COMMITMENT

The need to operate our educational facilities in a more efficient and effective manner is very obvious. Teachers should be aware of energy and consider what steps can be taken within their districts to reduce the impact of these costs on the school budget. Any attempt to resolve this problem should be viewed as a community effort. The classroom teacher has both an obligation to address the energy problem and an opportunity to teach solutions not only within the educational environments but in the community as well. As problems are resolved within the schools, students take home new insights and, hopefully, will practice energy conservation within the home environment. The delivery system for these new concepts is in place. It is up to educators to commit themselves to the concept and practices of energy conservation.

ENERGY CONSERVATION: THE ROLE OF THE TEACHER

The logic behind the need for energy conservation is apparent; there is little anyone could say today to argue against it. Proof is presented by radio, newspapers, television, and in the price we pay for energy in our daily lives.

The important step in an energy conservation program is the one taken after becoming aware of the need for it. *This step is the conscious practice of those behaviors that make up a good energy conservation program.* The teacher can be instrumental in the formal program by reminding students of the things that must be done. This will not only heighten awareness but also change behavior regarding energy use.

The list that follows may seem very elementary. It is in these small everyday ways that we all can make a difference; little things add up—in dollars saved for the school district and in the creation of informed and energy-conscious students.

WHAT TEACHERS CAN DO

- Keep doors and windows closed when the building is being heated or cooled.
- Turn off lights when rooms are unoccupied.
- Open shades on bright days to make use of natural lighting.
- Arrange student seating to optimize natural and artificial lighting.
- Do not adjust thermostats. Call the custodian.

- Do not block heating/cooling vents with books, coats, etc.
- Schedule parent conferences and extra-curricular activities to take advantage of the preheated or pre-cooled building.
- Wear warmer clothing in the winter and cooler clothing in the summer.
- Avoid using kilns and high electrical demand equipment during peak electrical hours, i.e., lunch period.
- Call the custodian or maintenance engineer whenever you spot a problem.
- Use exterior classroom doors for emergency only.
- Operate unit ventilators on low speed.
- Operate manual exhaust fans only when necessary.
- Check for ice or frost buildup in the refrigerator in the lounge.
- Turn off energy users when not in use, i.e., coffee pots, typewriters, fans, heaters, copy machines.
- In areas where there are controls to override master controls, make sure controls are returned to automatic when the room is unoccupied.

THE CLASSROOM—A SEPARATE UNIT

Schools are designed differently than our homes. Each classroom and office operates as a single unit with its own heating unit, thermostat, doors and windows. If the doors are open, room heat escapes to the corridor causing the thermostat to sense a false temperature reading and create a hot and cold room. Opening windows can cause drafts that will affect heating or cooling in the same manner. The only exception would be in mild weather when heating and air conditioning are off. Then it *is* wise to use windows and doors for free ventilation rather than using power driven fans.

When an area is being used, operate only the lights necessary for the task to be accomplished. If the room has minimum occupancy, arrange the students so that only a portion of the lights need to be operated. Make use of natural lighting by the windows when possible and turn off the row of lights for that section. There is really no reason for lights to be on when no one is in the room.

The stationary heating units in your rooms may function contrary to your imagination. Unit ventilators receive room air through a louver in the front and outside air from a louver on the roof or outside wall. This unit heats the air and exhausts it back into the room by means of a fan with multiple speeds. If these units are blocked by boxes, books, paper, plants, or any other object, heating will be erratic and also the unit can be damaged.

Have you heard the phrase "wind chill?" If room temperatures are at 65° to 68°, the room will be comfortable if operating fans are at low speed. The higher the fan speed, the greater the draft or wind chill even though the temperature output of the heating coil does not change.

If you have a true problem of erratic heating and cooling in your room, contact the responsible custodian or maintenance person to repair the malfunction on the unit or controls.

If your room has an exhaust fan with a manual switch, do you use it wisely? Exhaust fans are for the purpose of exhausting fumes, odors, moisture and excessive heat. When fans operate, they remove heated and cooled air from the room. When they are needed, they should be used. When they are not needed, they should be OFF. If manual switches are used for control, sometimes we forget to turn them off. If this is the case, request a twist timer to replace the manual switch; this will provide shutdown.

ENERGY CONSERVATION AND FEELING COMFORTABLE

A comfortable classroom environment and the conservation of energy can be created simultaneously. The teacher, again, can play an important and effective role in both.There are many factors working together to determine whether the occupants of a room feel comfortable at a particular temperature. Of these factors, many can be controlled. These factors are outlined below.

FACTORS AFFECTING THERMAL COMFORT

1. Temperature
2. Humidity
3. Air velocity in space
4. Wind chill factor
5. Radiative heat transfer
    - Proximity to cold/warm surfaces
    - Room temperature
    - Outside temperature
    - Solar
    - Number and intensity of lights
6. Convection currents (cold drafts)
    - Interior/exterior walls

- Insulation in walls and ceilings
- Window area
- Outside wind velocity
- Types of surfaces (brick, wood, cloth)

7. Mental state
   - Stress (exams)
   - Fear
   - Anxiety
   - Anger
   - Other problems (domestic, financial)
8. Physical state
   - Level
   - Clothing
   - Biocycles
   - Health (body temperature regulation)
   - Physical characteristics
   - Fatigue
   - Medication

How to Control Thermal Comfort Factors

Controllable Factors

1. **Temperature**
   - Boiler water temperature
   - Heating loop temperature—Reset hot water temperature based on outside air temperature
   - Thermostat settings
   - Keep heat transfer surfaces clean (convertors, coils)

2. **Humidity**
   - Use humidification
   - Reduce intake of dry outside air
     - Seal cracks
     - Install weatherstripping
     - Reduce outside air intake of fan systems
     - Reduce exhaust air

3. **Air velocity in the room**
   - Reduce fan speed during periods of low humidity (i.e., cold weather)
   - Air balance
   - Point diffusers away from occupants
   - Reduce speed on return fans

4. **Wind chill factor**
   - Increase humidity
   - Reduce air velocity
   - Add clothing

5. **Radiative heat transfer**
   - Keep desks/seating away from outside walls.
   - Maintain an even room temperature.
     - Insulate outside walls/ceilings
     - Reduce window areas
     - Keep heating units unobstructed
   - Close drapes, shades, or blinds during cold weather to reduce radiative heat loss of rooms facing non-sunny side or when not exposed to sunlight.
   - Utilize solar heating whenever possible. Incorporate passive solar heating and reflective surfaces to utilize free heating.
   - Lights are a source of heat. Brightly lit rooms may tend to overheat when other rooms remain cool. Keep lighting consistent throughout the building.

6. **Types of surfaces**
   - Keep desks/seating as far away from exterior walls in order to reduce their effect on temperature perception.
   - Insulating walls and ceilings will keep temperatures in room more stable.
   - Reducing the window area will also help stabilize room temperatures by reducing heat loss through them, as well as reducing the possibility of infiltration. In addition, it may be possible to:
     - install drapes, blinds or shutters
     - cover windows with insulated panels
     - install thermal or storm windows.
   - Insulate walls/provide wind breaks.
   - Cover surfaces that readily transfer heat such as metal, brick, stone, or glass.

Non-Controllable Factors

1. **Mental state**

   There is little control over the mental or physical condition of the individual. In many cases, the temperature of the room does not determine whether a person "feels" warm or cold. If all the occupants feel cold in the room, however, it is an indication that the problem stems from the physical surroundings and the temperature controls rather than being mental in nature. Therefore, several occupants must be questioned to determine the source of the problem.
2. **Physical state**

   The physical state can be controlled to some degree by the level of activity in a particular room, amount of clothing worn, the amount of drugs or medication taken (Note: Caffeine and nicotine are both drugs that can affect the body state and the body's temperature perception), and the level of fatigue. Other physical factors such as health and physical size or makeup cannot be controlled. One may feel cold or warm regardless of the room temperature if he/she has a cold or is in poor health. A slender individual may feel colder than a large person (although this is not always the case).

The generally accepted comfort range in schools is between 65°and 72° degrees for normal use, depending on the level and type of activity. Temperatures should be adjusted within this range to satisfy the large majority of the building occupants depending on the particular physical conditions of the space. Temperatures should seldom, if ever, exceed 68° to 70° in a normal classroom. If this temperature is not sufficient, there may be problems with the heating control system or the structure of the building itself. These problems should be identified and resolved.

PART X—TRANSPORTATION ENERGY CONSERVATION

A school district's transportation fleet is its most visible support operation and a major energy user. Consequently, a strong energy conservation program in transportation is one of the district's most valuable conservation efforts, both in terms of savings and public relations. Experts suggest that implementing a sound transportation energy conservation program can reduce a school district's transportation fuel consumption 5 to 20 percent without much cost beyond the usual vehicle replacements. This section will explore transportation energy conservation as it relates to planning and implementing energy conservation in the school district's transportation fleet.

Completing the ***Transportation Fleet Questionnaire*** that follows can help a district begin to identify the current status of the energy conservation program for transportation. A number of "no's" and "unknown's" indicates that ideas in this section can help the district improve its program and save energy.

TRANSPORTATION FLEET QUESTIONNAIRE

		Yes	No	Unk
1.	Does your district have a policy on energy conservation in the transportation fleet?	___	___	___
2.	Have school policies that affect transportation efficiency been reviewed and modified, where feasible, to increase transportation fuel economy?	___	___	___
3.	Are monthly fuel consumption records for all vehicles maintained and monitored?	___	___	___
4.	Are bus drivers familiar with fuel saving techniques?	___	___	___
5.	Are individual drivers aware of their fuel economy performance?	___	___	___
6.	Is there a unit on "driving for fuel economy" in the bus driver training program?	___	___	___
7.	Are posters, handouts, pamphlets, and other media used to promote driving for fuel economy?	___	___	___
8.	Is fuel-efficient driving performance recognized and rewarded?	___	___	___
9.	Are periodic meetings held to discuss performance and present fuel economy ideas?	___	___	___
10.	Do vehicle records offer the district an early-warning system for equipment replacement?	___	___	___
11.	Is fuel economy data used to influence purchasing decisions?	___	___	___
12.	Are fuel and equipment purchased in unit loads (e.g., truckload gallons) whenever possible to take advantage of discounts?	___	___	___
13.	Are vehicles assigned for the most effective and efficient use?	___	___	___
14.	Are suppliers being asked for suggestions on how to increase fuel economy and reduce costs?	___	___	___
15.	Is fuel saving equipment considered in purchasing?	___	___	___
16.	Has vehicle warm-up been reduced to a minimum?	___	___	___
17.	Are bus stops spaced as far apart as is feasible?	___	___	___

18. Are central collection points used whenever possible? ___ ___ ___
19. Are bus routes consolidated as much as possible? ___ ___ ___
20. Are school athletic trips and field trips combined to maximize bus use? ___ ___ ___
21. Are bus routes re-evaluated periodically during the year to ensure that equipment, labor and time is used most effectively? ___ ___ ___
22. Are detailed equipment performance records kept? ___ ___ ___
23. Is fuel economy considered in routine maintenance (e.g., tire pressure, ignition timing, etc.)? ___ ___ ___

PLANNING FOR ENERGY CONSERVATION IN TRANSPORTATION

ESTABLISHING POLICY

(Note: A sample district transportation policy is located in Appendix C.)

The commitment to energy conservation in transportation flows from the school board's general statement on energy conservation. Central administrative support is essential in goal setting, leadership, allocations, evaluation and reporting. There will be difficult decisions in transportation energy conservation—most notably involving vehicle assignments and school bus use. The administrator responsible for transportation energy conservation must have support in these matters.

The 11 considerations that follow are important as a school district establishes new policies for energy conservation in its transportation fleet:

1. Review the district's servicing boundaries to identify opportunities for reducing bus service. Investigate possibilities for combining bus routes with adjoining districts, particularly for handicapped students.
2. Review possible changes in the school day schedule to reduce bus travel.
3. Consider increasing student walking distances to eliminate courtesy busing or shorten routes.
4. Consider restrictions on travel. For instance, eliminate summer school transportation. Encourage public transportation where available.
5. Consider reducing the number of school field trips. Combine trips and limit to full load.
6. Establish minimum and maximum distances for field trips.
7. Consider coordinating with other districts to share buses for athletic events and to combine maintenance facilities.
8. Think about encouraging alternative methods of transportation.
9. Consider routing changes. For instance, increase the distance between student pick-up points to reduce the number of stops.
10. Consider ways to train drivers in fuel economy.
11. Coordinate calendar with other districts as much as possible.

WHO'S RESPONSIBLE?

Organization for transportation energy conservation depends on the size of the district and its organization for energy conservation. If there are building committees throughout the district, then a transportation committee might be appropriate. Members of the committee could include the transportation supervisor, the business official, a bus driver and the chief mechanic. In addition, the committee could include interested students, faculty and community members.

The transportation supervisor, the business official, and the bus drivers all have major responsibilities in any transportation energy conservation program.

The **Transportation Supervisor's** responsibilities include:

- Coordinating routes for minimum mileage, stops, deadhead, backtrack and safety.
- Coordinating routes for maximum numbers of riders with minimum ride time.
- Reviewing maintenance tasks and schedules.
- Investigating complaints and suggestions and taking appropriate actions.
- Maintaining rapport among the drivers.
- Enforcing discipline when necessary.
- Maintaining and accounting for parts inventories.

The **School Business Official's** responsibilities include:

- Budgeting appropriate dollars for transportation.
- Providing funding for support services.
- Implementing proper insurance coverages.
- Preparing forms for state/federal aid.
- Assisting with purchasing of buses, equipment and supplies.
- Handling the responsibilities of the transportation supervisor should the district not have the position.

The **Bus Drivers'** responsibilities include:

- Notifying the transportation supervisor of needed routing changes to save stops and/or mileage.
- Notifying the transportation supervisor of safety problems in bus or route roadway.
- Notifying the supervisor of inoperable equipment on the bus.
- Notifying the supervisor of student problems.
- Driving in an energy efficient manner at all times.

In any successful program these people must work together toward a common goal clearly outlined and supported by the superintendent and school board. In districts with large fleets, it is often wise to appoint one person as the Energy Conservation Transportation Officer with reporting and oversight responsibility for the total program.

FIVE MAJOR AREAS OF TRANSPORTATION ENERGY CONSERVATION

The following five areas should be carefully considered by any district which has decided to make an energy conservation effort in its transportation fleet:

1. Record Keeping
2. Maintenance
3. Driver and Mechanic Skills
4. Routing
5. Fleet Efficiency

RECORD KEEPING

A good fleet maintenance program should include a monitoring, tracking and recording information system that shows the fuel consumption and repair history of each vehicle in the fleet. The records required to support a transportation energy conservation program are virtually self-evident, but a few suggestions are appropriate. Four basic types of records should be part of every transportation energy conservation program:

1. A means of identifying each vehicle
2. A sure system to record fuel consumption
3. A garage or maintenance record system
4. A bus and fleet operations summary

VEHICLE IDENTIFICATION

Each vehicle should be assigned a number that can be used on all reporting forms relating to that piece of equipment.

FUEL CONSUMPTION

It is necessary to have a sound system to record fuel consumption for each vehicle. This might involve a fuel usage form, a mini-computer controlling the district's garage pumps, administrative limits on the use of outside service stations or any combination of these ideas. The system should also have provision for recording the odometer reading when the fuel tank is filled. Included in the Appendix is a suggested Vehicle Fuel Record to record daily fuel usage and a Monthly Vehicle Fuel Record used to summarize per vehicle consumption.

MAINTENANCE RECORDS

Maintenance records are a necessity in any system. They provide past history and present evaluation of particular bus or fleet needs. It is very important that records be kept up-to-date and analyzed on a specific timetable.

A record file should be established on each bus and should include all specifications and pertinent data on the unit. It may be useful to have one file for the chassis and one for the body since normally there will be a manufacturer for each. This file should be kept at the bus garage for reference and updating.

By having a record system that is up-to-date there will be a history on each unit. This type of record can alert a supervisor to particular problems with one bus or with a number of buses by the same manufacturer. It can help the transportation supervisor stock proper parts, discover manufacturing problems and plan for preventive maintenance.

BUS AND FLEET SUMMARY

In order to cut costs and improve efficiency of the transportation program, it is useful to establish a fleet database. By using the suggested SDEP sample forms, ***Bus Matrix*** and ***Fleet Matrix*** (pages 73 and 74), the district can develop a fleet comparison by month, term or year.

The Bus Matrix is designed to develop data on an individual bus basis and provides data for use in the Fleet Matrix. A completed Fleet Matrix can help a district find answers to critical questions in three areas of major concern to a successful energy conservation program. Such questions include routing, policy and operational costs.

1. **Routing**
   - Are all buses needed?
   - Could two routes be combined?
   - Are all runs necessary? Are all stops necessary?
   - Can mileage be cut by alternate routes?

2. **Policy**
   - Does ride time create a discipline problem?
   - Can walk distance be changed to eliminate extra mileage?
   - Are schedules corresponding with routing?

3. **Operational Costs**
   - What fuel is best?
   - Can MPG be increased?
   - Can maintenance cost be lowered?

BUS MATRIX

Bus No. ____________________ Driver's Name ____

Seating Capacity ________________________ Number of Runs _________________________________

	Rider Designation*	A.M.	Noon	P.M.	Average
No. of Riders per Run					
No. of Miles per Run					
No. of Stops per Run					
	▨				
Time In	▨				
Run No. 1 Time Out	▨				
TIME Total Time	▨				
LINE Time In	▨				
Run No. 2 Time Out	▨				
Total Time	▨				
Miles In					
Run No. 1 Miles Out					
MILES/ Miles Traveled					
Miles In					
Run No. 2 Miles Out					
Miles Traveled					

**K—Kindergarten*
E—Elementary
S—Secondary

FLEET MATRIX

ROUTING:

Total # buses: _____ ON line ___ Spares

Total # of seats _____

Total # of students transported _____

Kindergarten _____ Elementary _____ Secondary _____

Total # of runs daily: AM _____ Noon _____ PM _____

Total miles per year _____

Average miles per bus: Year _____ Day _____

No. of stops per day _____

Average # of stops per mile _____

POLICY:

Maximum ride time in minutes: Kindergarten _____ Elementary _____ Secondary _____

Walk to stop distance in miles: Kindergarten _____ Elementary _____ Secondary _____

Walk to school in distance in miles: Kindergarten _____ Elementary _____ Secondary _____

Current school starting times schedule: Kindergarten _____ Elementary _____ Secondary _____

Maximum distance in miles for extracurricular activities: Field trips _____ Sports _____

OPERATION COST:

Fuel cost per gallon: Gas _____ Propane _____ Diesel _____

Average MPG: Gas _____ Propane _____ Diesel _____

Average maintenance cost per bus per year: $ ________________

Average cost per mile _____ Per student _____

BUDGET:

Budget total per year $________________

Salaries $________________

Fringes $________________

Facility cost $________________

Maint equipment cost $________________

Parts cost $________________

Oil cost $________________

Fuel cost $________________

Bus purchases $________________

Insurance $________________

Contracted services $________________

MAINTENANCE

Keeping buses properly tuned and maintained is an important part of the energy conservation program for the transportation fleet. A good preventive maintenance program for any transportation fleet is vital.

School bus preventive maintenance is a scheduled maintenance check program based on a time or mileage period. A good PM program should include all aspects of the bus, such as engine, driveline, exhaust system, cooling system, frame and body, brakes, lights, instruments, cab and bus interior and two-way radio check.

The PM program should be accomplished through a checklist to be sure that none of the items are missed. A suggested SDEP sample form, ***Transportation Preventive Maintenance Checklist,*** is included on pages 76-81.

Preventive maintenance should be scheduled for each bus on a time or mileage basis, derived from the length of the route, types of roads traveled and type of engine powering the bus. All variables must be considered. If a bus travels on gravel roads, it will require more frequent service than a bus that travels pavement. A diesel bus may have different service intervals than a gasoline bus. The schedule should also correspond with the number of buses and available personnel to service them.

Listed below are a few of the major items a district should keep in mind when developing and implementing a bus maintenance program:

1. According to the Car Care Council, a properly tuned engine can increase efficiency as much as 11 percent. Proper tire inflation will add approximately another five percent and wheel alignment another one percent. A properly operating thermostat can add up to another seven percent. ***The result could be a 25 percent increase in efficiency.***
2. Monitoring oil change intervals and using chemical analysis could save money and problems. Every bus has its own characteristics and each bus should be examined to determine appropriate oil change intervals; oil analysis, determining the point at which the oil starts to break down, can alert you to an engine problem. It indicates the presence of physical contaminants such as fuel, carbon, antifreeze, as well as dirt and metal. Oil analysis can be used for transmissions, differentials or any item that uses oil for a lubricant and can help ensure maximum mileage on purchased lubricants.
3. Proper usage and levels of lubricants are very important in a transportation program. Lubricants should meet or exceed manufacturer's specifications since proper lubrication eliminates excessive engine wear that could result in premature engine failure and increased maintenance downtime. *Note:* On some diesel engines it is possible to use too high a quality oil. Be sure to match the oil to the engine!
4. Oil levels can be critical in a good maintenance program. High oil levels result in blow-by and seal damage and waste oil. Low levels result in lack of lubrication, dry seals, wear on metals and hardening of rubber materials and gaskets.
5. Fuel additives supply top cylinder lube to the engine. The price and advantages should be weighed to determine their worth. Normally the mileage savings will be offset by the price of the product. However, careful record keeping may show that additives improve performance, lengthen engine life and lead to less maintenance.

TRANSPORTATION
PREVENTIVE MAINTENANCE CHECKLIST

Bus No.________________ Date________________

Engine Compartment	Okay	Needs Attention	Comment/ Correction
Lube Oil			
Power steering fluid			
Brake fluid level			
Coolant level			
Windshield washer fluid			
Oil filter			
Fuel filter			
Air filter			
Choke			
Carburetor			
Oil leaks			
Fuel leaks			
Hoses			
Belts			
Pollution controls			
Air compressor breather			
Crankcase vent			
Air dryer or alcohol injection			
Throttle linkage			

TRANSPORTATION
PREVENTIVE MAINTENANCE CHECKLIST (CONT'D)

Bus No.__________________ Date__________________

Engine Compartments (Cont'd)	Okay	Needs Attention	Comment/ Correction
Electrical connections			
Tuning of ignition system			
Transmission oil level			
Leaks			
Loose bolts			
Linkage			
Breather			
Mounts			
Driveshaft U joints			
Pilot bearings			
Yokes			
Lube			
Differential oil level			
Leaks			
Breather			
Springs broken leaves			
Loose U bolts			
Worn shackles			

TRANSPORTATION
PREVENTIVE MAINTENANCE CHECKLIST (CONT'D)

Bus No.________________ Date________________

Tires	Okay	Needs Attention	Comment/ Correction
Proper inflation			
Cuts, weathering			
Valve stems			
Debris in tread			
Studs, clamps, nuts			
Spacer			
Alignment			
Wear			
Tread separation			
Steering			
Leaks			
Draglinks			
Cylinder			
King pins			
Dampers			
Rubber bushings			
Alignment			
Bearing adjustment and lube			
Steering wheel play			

TRANSPORTATION
PREVENTIVE MAINTENANCE CHECKLIST (CONT'D)

Bus No.________________ Date________________

Brakes	Okay	Needs Attention	Comment/ Correction
Inspect all lines			
Cams			
Calipers			
Wedge			
Chambers			
Leaks			
Drags			
Drums			
Linings			
Emergency system			
Adjustment			
Exhaust			
Leaks			
Heat risers			
Clamps			
Hangers			
Clearances			
Electrical			
Lights			

TRANSPORTATION
PREVENTIVE MAINTENANCE CHECKLIST (CONT'D)

Bus No.________________ Date________________

Electrical (Cont'd)	Okay	Needs Attention	Comment/ Correction
Battery			
Fuses			
Fans			
Instruments			
Frame and Body			
Mounts			
Rust			
Dents			
Loose sheet metal			
Hood latch			
Door operation and linkage			
Emergency door			
Windows and operation			
Mirrors and adjustment			
Cab and Bus Interior			
Seats			
Shift tower			
Pedal operation			
Two way radio operation and mounting			

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TRANSPORTATION
PREVENTIVE MAINTENANCE CHECKLIST (CONT'D)

Bus No.__________________ Date__________________

Cab and Bus Interior (Cont'd)	Okay	Needs Attention	Comment/ Correction
Seats			
Hand rails			
Guards			
Safety equipment			
Loose screws or bolts			

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DRIVER AND MECHANIC SKILLS

Skilled and trained personnel can make a big difference in the success of a district's transportation fleet energy conservation program. In this respect, two groups are of particular importance. Skilled mechanics are a crucial component as are energy-aware bus drivers.

MECHANICS

An integral part of any vehicle maintenance program is the servicing personnel. Decisions on the following issues are vital in planning and implementing a successful transportation fleet energy conservation program:

1. Are mechanics in-house or contracted out? What are the relative costs to the district?
2. Do mechanics receive expert training?
3. Are service personnel trained to check for fuel economy? What is the fuel-security system? Who is responsible for maintaining fuel economy records?
4. Can the district combine maintenance personnel with other districts to lower overhead?

It is very important to have mechanics who are knowledgeable and able to perform maintenance to keep buses operating at peak efficiency. In this day and age of alternative fuels, changing engine designs, diesel engine use, and gadgets to improve fuel economy, mechanics need expert training to achieve optimum levels of performance. This can be accomplished by in-house training, trade schools or through a local college or university.

BUS DRIVERS

Drivers can make a big difference in the district's fuel management program, so the driving staff should be trained and motivated to use fuel-saving driving techniques. The supervisor should ride with each driver and point out problem areas at the end of the ride.

Changing driver attitudes is the key to success or failure in improving efficient driving techniques. The following are tips for motivating drivers to drive for greater fuel economy:

1. Re-examine the driver training program and update it to meet the district's fuel economy management goals. Films and speakers can have an immediate impact.
2. Develop a spirit of friendly competition among drivers by publicizing good driver performance. One way is to post a chart of individual driver fuel consumption on the bulletin board.
3. Establish a floating trophy for the driver who has the best MPG increase each month.
4. Place fuel economy flyers in driver paycheck envelopes.
5. Solicit ideas from drivers for improving economy performance.

Training drivers in techniques that increase fuel efficiency can realize big savings. Make sure all bus drivers are aware of and practicing energy-efficient driving techniques. Include a unit on "driving for increased fuel economy" in any bus driver training. Listed below are some driving tips that can improve miles-per gallon performance. This list or a similar one can be posted in buses or lounge areas.

HOW TO INCREASE TRANSPORTATION EFFICIENCY: HOW TO ECONOMIZE

THINK FUEL ECONOMY

1. Maintain a steady, soft foot on the gas pedal.
2. Don't pump the gas pedal.
3. Observe the speed limit. Don't speed.
4. Accelerate smoothly from a stop and when changing speeds.
5. Anticipate stops.
6. Watch traffic far ahead so you can plan traffic moves early; use the brakes sparingly.
7. Never ride the brake or clutch.
8. Merge smoothly; time vehicle approaches.
9. Adjust driving methods to road conditions.
10. Minimize or eliminate engine warm-up time.
11. Drive slowly during engine warm-up periods.
12. At intersections on a hill use the brake instead of the clutch to hold position.
13. When starting uphill use the brakes to prevent rolling backwards.
14. Don't start the engine until everyone is ready to go; avoid jackrabbit starts.
15. Don't "rev up" the engine before turning off the ignition.
16. Turn off all power consuming systems before turning off the ignition.
17. Shut off the engine if the vehicle is going to be stopped for more than one minute.
18. Avoid fuel spillage when refueling buses.
19. Maintain patience, courtesy and good humor.
20. Make driving a personal contest; try as many fuel economy operating techniques as possible.

ROUTING

School bus routing has great potential for energy savings, but it is also a rather complex and technical process. What follows are some of the principles that should be covered in any routing system designed to include a concern for energy conservation.

Tips for Routing

The basic principles behind energy-conscious routing are clear:

1. Eliminate deadhead miles, backtracking and overlapping.
2. Reduce the number of bus stops per mile by establishing building service areas and/or increasing student walking distance.
3. Reduce bus standing time by reducing warm-up time and lengthy stops.

Accomplishing these goals, however, can be a complex task. Listed below are some tips that can be used to design fuel-efficient routes.

IDEAS IN DESIGNING PRACTICAL ROUTES THAT PROMOTE FUEL ECONOMY

1. Insofar as possible, routes should begin at the periphery of the school attendance area and follow the shortest, safest way to school.
2. Road conditions and traffic volume effects on route time and distance should be analyzed and given consideration in vehicle assignment.
3. Recognizing miles are cheaper than buses, use multiple trip routing when possible; a bus can service more than one route.
4. When possible, reduce the number of bus stops along a route. This reduces safety hazards in loading/unloading pupils; it also is a fuel economy measure.
5. Use expressways for express runs and "deadheading" only.
6. Do not schedule multiple buses over the same route; it provides pupils with an opportunity to ride any bus that comes along and can affect safety and fuel economy.
7. Eliminate door-to-door service; use zone loading servicing whenever feasible.
8. If possible, eliminate natural hazards (e.g., hills) and man-made hazards (e.g., railroad crossings, dead-ends and private roads) along each route.
9. Use feeder buses to increase safety and fuel economy.
10. Residence side load/unload on heavily traveled roads.
11. Increase pupil walking distance when safe and practical to do so.
12. Use the most efficient bus on the longest run.
13. Do not use bigger and less fuel-efficient buses than needed.

COMPUTER ROUTING

Deciding whether or not computerized routing makes sense for a district can be a difficult task. An experienced transportation supervisor who knows the district well can usually do a fair job of routing if he/she works in a small school system. Most bus supervisors today are using the "string and pin" method or some variation to lay out bus routes. Basically this method is sound but quite time consuming and quickly outdated. Factors involving safety, efficiency and economy are sometimes left to chance.

In many districts, the job has grown too big to continue to utilize manual methods. In the age of computerization, a computer routing system can be a viable alternative for route planning.

Since the majority of school bus fleets are in the medium to small category, many administrators feel that they are not justified in moving to data processing. Cost is a major factor as are lack of skilled personnel and data processing equipment. Renting equipment for processing transportation data alone is extremely expensive. Some regional districts may have the equipment and personnel necessary to accomplish computerized routing. For those districts that do not and are interested in investigating the possibilities of computerized routing, there are many computer firms set up to handle this type of business.

Large school systems desiring to purchase their own data processing systems probably should go directly to a computer manufacturer. If the extent the computer is to be utilized does not warrant the expense involved in purchasing costly equipment, the district can consider "time sharing" (hooking a computer terminal into a main computer bank and paying a monthly rental and service charge), or the district could consider the possibility of contracting with a consultant firm that operates a computer scheduling system.

FLEET EFFICIENCY

A more efficient bus fleet can be achieved through purchase of new, more fuel-efficient vehicles and/or through conversion of present vehicles. Each district must consider both these options and develop a plan that will balance energy savings from new and converted equipment against the costs for replacement and modification.

GENERAL PURCHASING GUIDELINES

Unlike energy conservation in buildings where errors in initial design might persist for a half-century, inefficient vehicles are generally replaced after a few years. Even smaller districts replace a few vehicles each year, so the most energy-efficient technology should be evaluated as soon as it arrives on the market.

It is axiomatic that the smallest and lightest vehicle appropriate for the use be purchased. This should be rigidly enforced. District personnel should work closely with equipment dealers to specify the smallest bus that will best meet the district's needs in the most cost effective manner.

In addition to factors such as fuel consumption and maintenance requirements, factors relative to bus use patterns must be considered. The numbers, age and physical condition of pupils must be considered as must the type of route the bus will be running. Factors such as average and maximum driving speeds, general road conditions and length of trips must be included in purchase planning.

Below is a list of factors that should be considered when deciding on bus specifications:

- Consider diesel powered automatic transmission buses with turbocharger options.
- Consider propane powered buses.
- Specify a fan clutch or temperature-modulated fan to reduce engine power demand.
- Consider a high-temperature thermostat or shutters for your school bus to help keep the engine in the high efficiency operating range.
- At a minimum, compare fuel savings payback and return on investment of equipment purchase.
- Purchase the smallest bus with the smallest engine offering the most efficiency that fulfills transportation needs.
- Select school buses with streamlined frontal designs whenever possible.
- If possible, select an engine-vehicle combination that can be easily and inexpensively maintained and that offers the best fuel economy for your driving environment.
- Specify a low numerical rear-axle ratio.
- Select only the power accessories necessary for security and safety.
- select the transmission that offers the best performance in your driving environment

FUEL OPTIONS

Many school districts are either converting to or purchasing vehicles that use alternative fuels. The use of diesel-powered buses is gaining increasing popularity as mileage efficiency is nearly double that of gasoline while the fuel cost is usually equivalent. In addition, conversions to water injection and emission control systems have helped some districts increase fleet miles per gallon from 9 to 17 percent.

Districts should be aware that the Clean Air Act of 1990 requires that 50 percent of new vehicle purchases by governmental agencies be equipped to operate on alternative fuels in compliance with the Act. The chart on page 85, reprinted from Volume 1, Issue 1 (1991) of the Alternative Fuel Vehicle Report published by the Ford Motor Company, describes the advantages and disadvantages of various alternative fuels.

SUMMARY

There is a great potential for energy savings in the transportation fleet. Savings are possible in "quick-fix" areas such as driver training in energy-efficient driving techniques and improved vehicle maintenance. Major savings can be achieved through careful routing particularly if the district and community develop energy-conscious transportation policies. Energy savings can be achieved through judicious investment in a more efficient bus fleet. The suggested SDEP sample form, Transportation Checklist, included in Appendix C, lists numerous ways of conserving energy and reducing transportation costs.

Just as with a successful facilities energy conservation program, a successful transportation fleet energy management program must be carefully planned, implemented and monitored. It cannot be a casual or short term commitment. "Quick-fix" options have already been implemented by many districts. Community and board support are needed and must be maintained if some of the hard choices leading to greater savings are to be successfully implemented. The savings potential is there if a district and community recognizes the need and makes a serious commitment to balancing the costs of the transportation program against services provided.

ALTERNATIVE FUELS COMPARED TO GASOLINE FROM A FLEET OPERATOR'S VIEWPOINT

(INDEPENDENT OF REGULATORY REQUIREMENTS)

Alternative Fuel	**Advantages**	**Disadvantages**
Reformulated gasoline	• Usage in existing vehicles • No special refueling	• Higher cost fuel • Refinery capacity facilities • May not qualify as an alternative fuel
Liquefied petroleum gas (LPG) (dedicated)	• High octane	• Pressurized fuel tanks • Reduced fuel cost • Limited refueling sites • Higher cost vehicle • Resale value without adequate refueling infrastructure
Compressed Natural Gas (CNG)(Dedicated)	• High octane • Reduced fuel cost	• Pressurized fuel tanks • Refueling site cost • Higher cost vehicle • Significantly reduced driving range or cargo area • Resale value without adequate refueling infrastructure
Ethanol (E85) (Flexible fuel) Similar to methanol except much more expensive fuel cost without significant government subsides.		
Electric Vehicles	• Refueling sites	• High cost of battery replacement • Significantly reduced driving range • Reduced performance • Battery recharge time • Battery disposal

PART XI—PUBLIC UTILITIES: DEMAND SIDE MANAGEMENT

Demand side management (DSM) of energy usage has been fostered in several ways by New Jersey's public utilities. This section examines key aspects of this strategy and describes numerous DSM opportunities available in New Jersey. Similar opportunities are available in many other states, but the following examples of DSM programs can serve as models for implementation elsewhere.

OUTLINE OF DSM PROGRAMS FOR SCHOOL DISTRICTS IN ETG TERRITORY

1. **Commercial and Apartment Conservation Services Program (CACS AUDIT)**
   Your gas supplier may be willing to provide certified auditors to perform energy audits for public and private schools that are gas heating customers to identify problems and enumerate measures resulting in energy savings. The cost of the audit will be as follows:
   - $25.00 for buildings up to 5,000 square feet
   - $50.00 for buildings 5,001 to 25,000 square feet
   - $75.00 for buildings 25,001 or more square feet
   - No charge for nonprofit, local government and housing authority buildings

   The commercial energy program is available to gas heating customers on General Service, Multiple Family Service and Temperature Control rates, where average annual energy use for the last twelve months was less than 4,500 MMBTUs.

2. **Conservation Awareness in the Schools**
   Your gas supplier may work with the schools in its service territory to sponsor presentations, printed materials or programs to promote energy awareness.

3. **Natural Gas Cooling Rebate Program**
   Your gas supplier may offer cash rebates of up $100 per refrigerant ton (up to a maximum $30,000 per machine) to owners and/or operators of industrial or commercial buildings who install natural gas cooling or natural gas chiller/heater systems.

PART XII—BUILDING LIFE CYCLE COST

INTRODUCTION TO THE BUILDING LIFE CYCLE COST (BLCC) PROGRAM

Your local public utility company may be willing to assist you in developing a Life Cycle Cost Program, a program designed by the National Institute of Standards and Technology (NIST). The program can be used for single maintenance changes, renovation of a building, new building equipment, purchasing of a single bus, truck or fleet, office copiers, etc. It will produce Savings to Investment Ratio (SIR) and Adjusted Internal Rate of Return (AIRR). The program has incorporated energy cost tables that can be updated with data provided by the U.S. Department of Energy (DOE).

The program will print all reports in a format that provide school districts with a decision making process not previously available. A printout of a sample program dealing with replacing incandescent lamps with high efficiency neon lamps is found on the following two pages.

BASE CASE ASSUMPTIONS

Exit Signs (50)
Replace 100 Incandescent Lamps with 100 High Efficiency Neon Lamps

SPECIFICATION	UNITS	EXISTING	PROPOSED
PART 1 CAPITAL COSTS			
Type		Incan	Neon
Manufacturer		Gen Elec	Martek
Industries			
Lamp		Ge 20t6	Pml-M
Energy Consumed	Watts/Hr	20	1.5
Use	Hours/Day	24	24
Life	Hours	2190	87600
Life	Years	0.25	10
Cost/Lamp	$$$	$0.75	$24.67
Cost/100 Lamps	$$$	$75.00	$2,467.00
Lamps Replaced		100	100
PART 2 OPERATING COSTS			
Municipal Rate	$/Kwh	$0.10	$0.10
Annual Consumption	Kwh	17520	1314

PART 3 MAINTENANCE

Labor	$/Hr	$15.00	$15.00
Efficiency	Lamps/Day	100	100
Cost Replace 100 Lam	$$/Day	$105.00	$105.00
Annual Maint	$$	$420.00	$10.50

PART 4 SUMMARY

Total Cost 10 Years	$22,637	$6,697
Savings 10 Years		$15,940

NIST BLCC: COMPARATIVE ECONOMIC ANALYSIS

Base Case: Exit Incandescent
Alternative: Exit - Neon

PRINCIPAL STUDY PARAMETERS:

Analysis Type: Generic LCC Analysis - No Tax Analysis
Study Period: 10 Years (1992 Through 2001)
Discount Rate: 5.0% Nominal (Including General Inflation)
Base Case LCC File: XINCAN.LCC
Alternative LCC File: XNEON.LCC

COMPARISON OF PRESENT-VALUE COSTS

	Base Case: Exit Incan.	Alternative: Exit-Neon	Savings From Alt.
INITIAL INVESTMENT ITEM(S):			
Cash Requirements as of Occupancy:	$300	$2,467	-$2,167
Subtotal:	$300	$2,467	-$2,167
FUTURE COST ITEMS:			
Annual and Non-Annual Recurring Costs	$4,200	$110	$4,090
Energy Expenditures	$17,837	$1,653	$16,184
Replacements to Capital	$300	$2,467	-$2,167
Subtotal	$22,337	$4,230	$15,940
Total P.V. Life-Cycle Cost	$22,637	$6,697	$15,940

NET SAVINGS FROM PROJECT EXIT-NEON COMPARED TO PROJECT EXIT INCAN.

Net Savings = P.V. Of Future Cost Savings	$18,107
- Increased Initial Invest.	-$2,167
Net Savings:	$15,940

SAVINGS-TO-INVESTMENT RATIO (SIR) FOR PROJECT EXIT–NEON COMPARED TO PROJECT EXIT–INCAN.

$$\text{SIR} = \frac{\text{P.V. Of Future Cost Savings}}{\text{Increased Initial Investment}} = 8.36$$

Adjusted Internal Rate of Return (AIRR)
For Project Exit - Neon Compared to Project Exit Incan.
(Reinvestment Rate = 5.00%: Study Period = 10 Years)
AIRR = 29.83%

PART XIII—IN-HOUSE INCENTIVES PROGRAM

INTERNAL SHARED SAVINGS SYSTEM

OBJECTIVE

To develop an "In-House" shared savings system that will provide financial incentives to the principals and possibly staff at each school. This system will keep an on-going awareness and incentives to reduce energy consumption and increase energy conservation. These savings will be utilized to provide educational materials or awards and to improve the learning environment within the school.

The concept behind the system would be similar to the shared saving systems currently in use at other school districts. However, instead of 50/50 savings with an outside contractor, 100 percent of the savings will go to the district. This system would operate without the ongoing external assistance from federal or state agencies and would be completely self contained within the utility account budgets.

HIGHLIGHTS

- Return energy savings to district surplus and discretionary accounts at each school based on a percentage basis.
- Transfers would occur on a monthly basis.
- An automated energy accounting system will maintain actual, budget and target consumption and cost. The system will track school by school energy conservation effectiveness. (See Figure 1 on page 93.)
- School use after regular hours will be credited directly to the utility accounts.
- Savings will be determined on the current fiscal year budget dollars and consumption levels. The target will be developed based on an average of three fiscal years called the "Base Year" and the overall percent reduction objective.
- The sharing distribution factors would ideally be as follows:

	District	School	Total
Above Budget	0.00	1.00	1.00
Below Budget & Above Budget	0.50	0.50	1.00
Below Target	0.00	1.00	1.00

- Savings would be based on consumption being below budget. If consumption is below budget the savings would be based as follows:

  Total Saving $ = Budget $ – Actual $

- If the actual consumption is greater than the budget consumption a penalty would be activated. The penalty would be as follows:

  Total Penalty $ = Actual $ – Budget $

  Note: The penalty is based on dollars only. This is a more conservative approach than determining the actual energy consumption difference (Budget vs. Actual) at the current energy per unit cost.

- Savings and penalties are accumulated on a month by month basis.
- The "Internal Shared Savings System" is based on actual energy consumption versus budget energy consumption. Whenever actual consumption is less than budget consumption the actual dollars minus the budget dollars are shared on a percentage basis (see Figure 1 on page 93).

AWARDING SAVINGS

Shared savings also requires shared awards. Savings by instructional staff and students are mainly related to operational functions. Turning off lights when not required, and closing doors and windows in the winter are the most obvious ways to save energy. Suggestions of how to save energy by staff and/or students, after review to determine paybacks, could produce further savings.

Savings made because of renovations of HVAC systems, lighting, double glazing etc., requiring long and short term financing, do not have instant paybacks as noted above.

Savings at individual buildings could be awarded with many variations—dollars for teacher administered classroom projects, certificates in value or recognition, to obtain other grants by and for teaching staff. Compensation related to employment terms (such as time off or bonus payment) could also be offered. These awards would not involve student participation in an energy saving project.

Awards could also be given for an energy-saving project that generated positive public relations, with appropriate documentation.

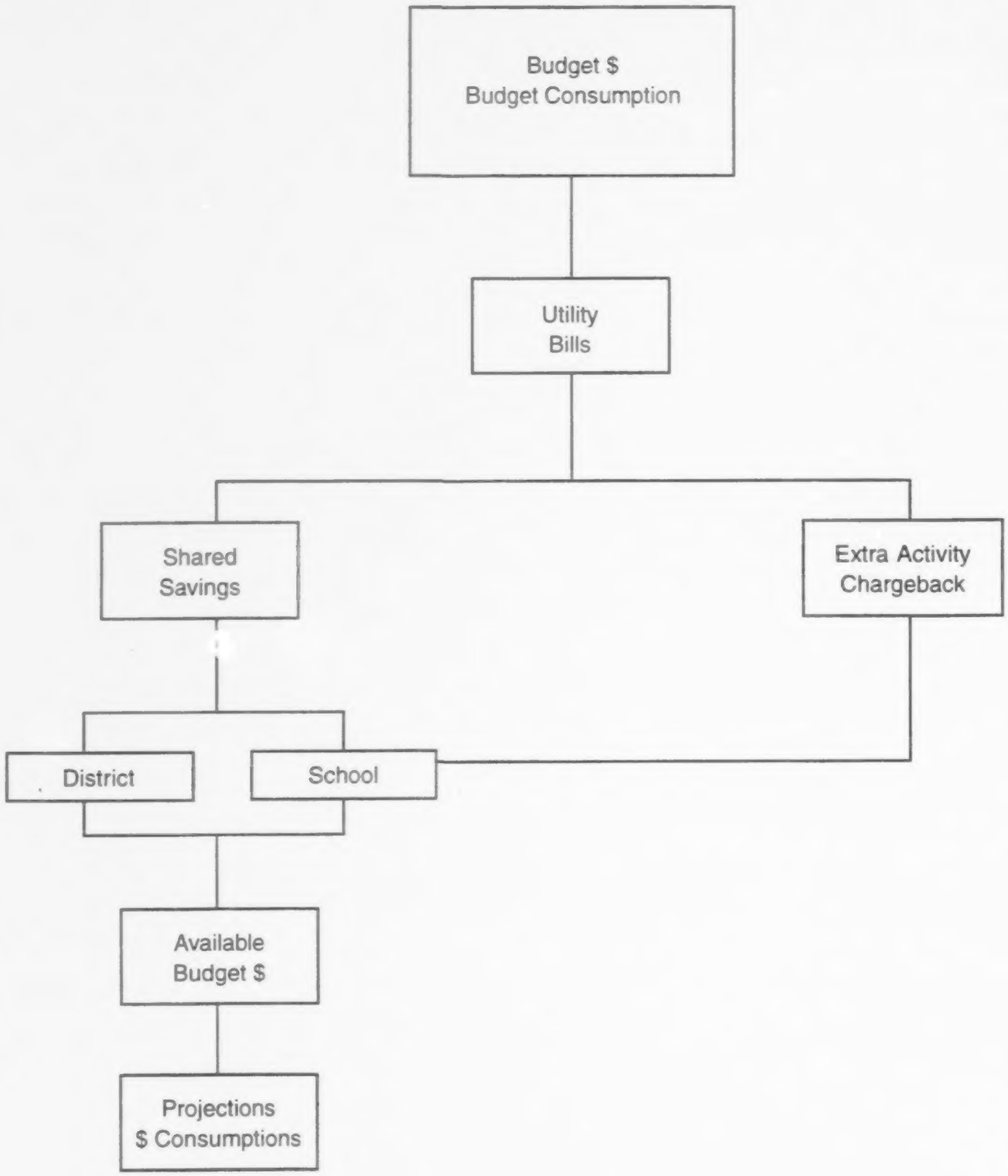
Shared-saving projects could also be awarded to maintenance personnel for any innovations in their school's mechanical operations or to finance new energy conservation projects.

Every user of a school, without exception, can contribute in a well publicized program. Even the public can be invited to participate.

Energy saving measures can be practiced at home, school and at work; but, it needs stimulation in the commnity by educators and by students to parents and other family members.

FIGURE 1

INTERNAL SHARED SAVINGS SYSTEM


Budget $
Budget Consumption
Utility
Bills
Shared
Savings
Extra Activity
Chargeback
District
School
Available
Budget $
Projections
$ Consumptions

PART XIV—AVAILABLE RESOURCES

ENERGY HOTLINE

Call your state department of energy and ask for your area's clearinghouse office and director. Try to secure a name and office number. By calling this number a school district can connect with the Energy Information Clearinghouse. This is a FREE service. The Clearinghouse staff is "on call" Monday through Friday to help with many kinds of energy questions. In addition, more than 150 publications on energy conservation are available. These publications provide details on the following:

- Using renewable resources—solar, water, wind.
- Implementing new technologies.
- Getting financial assistance.

In recent years, unpredictable energy costs have exerted a major impact on operating budgets. Through the ICP, an institution can affordably increase energy efficiency to better control operating costs and create a hedge against future energy price inflation.

ELIGIBILITY

Any public or private nonprofit school, college or hospital is eligible to apply for a grant. A building must have been in existence on May 1, 1989 and must be owned and primarily occupied by the institution in order to qualify.

PROGRAM PHASES

The program consists of three phases. All aspects of each phase must be completed prior to participation in a subsequent phase.

Phase I—The Energy Audit (E)

- The energy audit is a survey of a building that examines physical characteristics, energy consumption, the potential to save energy through low-cost or no-cost operating and maintenance improvements, and the need to initiate energy conservation measures (ECMs).
- Institutions that need to have an E performed should contact an ICP program representative immediately to arrange for this prerequisite audit in time to apply for a grant in the upcoming cycle.
- Although grants are not available for Phase I of the program, the Office of Energy can help you obtain an E at a very reasonable cost.

Phase II—Technical Assistance (TA) Analysis and Report

- After completion of Phase I requirements, an institution may apply for a 50/50 matching grant to commission a TA analysis. An architect or engineer from a pre-qualified firm will review the prerequisite E data and then conduct a detailed inspection of the institution's physical structure, energy system, operating practices and usage patterns.
- This study identifies all appropriate ECM's for the building and the capital expenses associated with the design, purchase and installation of each measure. In addition, the study estimates the annual energy savings potential of each measure and compiles all information into a TA report. The TA report offers the institution energy improvement alternative that serves as a blueprint for a Phase III grant application and also provides an energy retrofit strategy for the future.
- The TA analysis should be performed by a prequalified professional architect or engineer who is licensed within your respective state.

Phase III—Energy Conservation Measure (ECMs)

- Upon completion of the Phase II TA report, an institution may apply for a Phase II 50/50 matching grant to design, purchase and install the chosen ECMs recommended in the TA report.
- ECMs are retrofit measures such as caulking, weatherstripping, window modifications, fur-

nace and boiler upgrades and computerized energy management systems.

- In order to be eligible for funding, an ECM must have a simple payback of at least two years and no more than 10 years.

APPLICATIONS AND GRANT AWARDS

Check with your respective state agencies regarding annual funding cycles.

SPECIAL CASES

Contact your local agencies for criteria.

RETROACTIVITY

Funds spent to implement the ECMs recommended in an approved TA report prior to application submittal and grant award are not eligible for direct case reimbursement. However, the expenses incurred can be credited as part of the institution's matching fund requirements for other ECMs not yet implemented in the same building if all ECM's were included in the Phase III grant application. The retroactive ECMs are subject to the same review, scoring and ranking procedures as ECMs not yet implemented.

PART XV—GLOSSARY AND APPENDICES

COMMONLY USED ENERGY TERMS

Air changes:	Replacement of air in a room over a period of time. Often in cubic feet per minute (CFM).
Ambient Air:	Existing air.
Ambient Temperature:	Temperature out of doors.
Ammeter:	An instrument for measuring strength of an electric current.
Base:	A selected time unit with consumption level or dollar amounts to which all future usage of costs are compared.
Boiler Capacity:	The rate of heat output in BTU/H measured at boiler outlet, at the design pressure and/or temperature and rates fuel input at the site elevation.
BTU—British Thermal Unit:	The unit standard for measurement of the amount of heat energy. Equal to the amount of heat energy necessary to raise the temperature of one pound of water one degree Fahrenheit.
Building Envelope:	The elements of a building that enclose conditioned spaces through which thermal energy may be transferred to or from exterior.
Calorie:	Unit of quantity of heat. The amount of heat required to raise the temperature of one (1) kilogram of water one (1) degree centigrade.
Caulking:	A flexible material used to seal up cracks or spaces in a structure.
CCF:	A hundred cubic feet. Used as measure by natural gas companies for billing purposes.
Centigrade:	The temperature scale on which the freezing point of water is 0 degrees and the boiling point is 100 degrees at sea level.
CFM—Cubic feet per minute:	Usually refers to air flow. Standard method of measuring air flow.
Chimney Effect:	The tendency of the cold, denser outside air to replace the heated air through penetrations such as doors, cracks, fireplaces, etc.
Conduction:	Method of heat transfer where heat moves through a solid.
Conservation:	The care and preservation of natural resources.
Convection:	Method of heat transfer where heat moves by motion of a fluid or gas, usually air.
Degree Day:	The mean daily temperature. This is the average of the daily maximum and minimum

	temperature of any given day. The degree day value for any given day is the difference between 65 degrees and the mean daily temperature. *Example:* Mean daily temperature of 50 degrees the degree day is 65 minus 50 or a 15 degree day. Degree days are a measure of the severity of an entire season.
Demand Load:	The requirement of electric energy measured in 15 minute cycles for commercial operations. The price of electric usage is directly related to the level of this demand. The higher the demand, the higher the cost per electrical unit.
Design Temperature:	The difference between the desired indoor temperature and the outdoor temperature for a given locality.
Dry Bulb Temperature:	The temperature of the atmosphere as indicated by an ordinary thermometer.
Energy:	That which does or is capable of doing work. It is measured in terms of the work it is capable of doing; electric energy is commonly measured in kilowatt hours.
Environment:	The sum of all external conditions and influences affecting the life, development and ultimately, the survival of an organism. Everything that affects a living organism.
Exponential Growth:	An increase by a constant percentage of the whole during a constant time period. The doubling time is constant.
Fahrenheit:	The temperature scale on which the freezing point of water is 32 degrees and boiling point of water is 212 degrees at sea level.
Foot Candles:	A common unit of measurement of light at a given location. Energy of light from a distance of one foot from a standard candle.
Glazing:	Another term for glass used in windows.
Gross Square Feet (GSF):	The total number of square feet contained in a building envelope using the floors as area to be measured.
Heat Exchanger:	Any device that transfers heat from one fluid (liquid or gas) to another, to the environment, or from a hot substance to a cooler substance.
Heat Loss/Gain:	Refers to the quantity of heat (expressed in BTUs per hour) passing through a given section of material such as a furnace wall and, therefore, is not available for useful work.
Heat Pump:	A combination heating and cooling device. In winter it extracts heat from air as cold as 20 degrees; in summer, it works in reverse to become an air conditioner.
Heat Transfer:	Heat moves from a hot substance to a cooler substance radiation, conduction or convection.
Horsepower:	British unit of power, 1 H.P. = 746 watts or 42.408 BTUs of energy cosumed per minute.
Humidity:	The amount of water vapor within a given space. Higher humidity with lower temperature can still provide an acceptable comfort level.
HVAC:	A system that provides the process of comfort heating, ventilating and/or air conditioning within or associated with a building.

Infiltration:	The flow of air into a building through small openings.
Insulation:	A material used to minimize heat losses from a given space.
KW (kilowatt):	1,000 watts.
KWH (kilowatt hour):	A unit of work energy equal to that expended by one kilowatt in one hour is 3,413 BTUs.
Life Cycle Cost:	The total costing of new equipment for a lifetime period including anticipated dollar outputs for maintenance and operation. For accurate data, manufacturers should be consulted.
Plenum:	A large duct used as a distributor of air from a furnace.
Peak Load:	Literally, the maximum load in a stated period of time. Sometimes, the term is used in a general sense to describe that portion of the load above the base load for electrical billing.
Radiation:	The transfer of heat from one body to another by heat waves without heating the air between the bodies.
Refrigeration, Ton of:	Equivalent to the removal of heat at a rate of 200 BTUs. per minute, 12,000 BTUs per hour or 288,000 BTUs per day.
Relative Humidity (RH):	This is a measurement expressed as percentage, indicating the amount of water vapor in the air compared to the amount that the air could contain if it were completely saturated with moisture.
Resistance (R-Value):	Term used to measure insulation materials resistant to the flow of heat or cold in units of square feet per hour.
Retrofit:	The improvement of existing buildings to make them more energy efficient.
Setback:	Reducing the level of heat from the system to the lowest practical point especially in periods where permitted by the activities or occupation in the building.
Therm:	A unit of gas fuel containing 100,000 BTUs.
Thermal Barrier:	A strip of nonconducting material, such as wood, vinyl or foam rubber, separating the inside and outside surfaces to stop conduction of heat to the outside and the resulting cold surfaces inside.
Simple Payback:	The length of time required for an investment to pay for itself.
"U" Value (Thermal Transmittance):	Overall coefficient of heat transmission (air-to-air) expressed in BTUs per square foot per degree F. It is the time rate of heat flow. The "U" value applies to combinations of different materials used in series along the heat path flow, materials, air spaces, and surface air films on both sides. The lower the "U" value, the less heat transferred.
Ventilation:	The introduction of air into a space by some controlled mechanical system or unit.
Watt:	A unit of power that is produced when one (1) ampere flows under an electromotive force of one (1) volt.

Weather-stripping:	Metal, plastic or felt strips designed to seal between windows and door frames to prevent air infiltration.
Wet Bulb Temperature:	The temperature at which liquid or solid water, through evaporation under constant pressure and temperature, brings the air to the saturation point. This is commonly used to calculate humidity.

APPENDIX A—DATA COLLECTION

MONTHLY METER READING SHEET

Building

Reader's Name

Date of Reading

Meter #

Meter #

Instructions: Start from the right. Draw in arrow exactly as they are on the meter you are reading.

BIWEEKLY METER RECORD

Meter # ____Meter Use________ Power Domestic
(circle one)

Meter Multiplier______________________________ Lights Heating

	Year ____		Year ____	
	Meter Reading	Amount	Meter Reading	Amount
July 1				
July 15				
August 1				
August 15				
September 1				
September 15				
October 1				
October 15				
November 1				
November 15				
December 1				
December 15				
January 1				
January 15				
February 1				
February 15				
March 1				
March 15				
April 1				
April 15				
May 1				
May 15				
June 1				
June 15				
Total for Year				

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WEEKLY METER RECORD

Gas Consumption

Building________________________________ ____________SchoolYear

________________________________ ________________________________

Meter Meter Number

Date	Reading	Differential	Multiplier	MCF - CCF Weekly Consumption	MCF - CCF Monthly Consumption
APRIL					
Monday					
Monday					
Monday					
Monday					
MARCH					
Monday					
Monday					
Monday					
Monday					
FEBRUARY					
Monday					
Monday					
Monday					
Monday					
JANUARY					
Monday					
Monday					
Monday					
Monday					
DECEMBER					
Monday					
Monday					
Monday					
Monday					

Return one copy at the end of the month.

MONTHLY CONSUMPTION REPORT

Building Name ______________________________ Square Feet ______________

Month	Consumption Year Year	Consumption Sq. Ft. Year Year	% of Change	Consumption Yr. to Date Year Year	Expenditure Year Year	Cost/Sq. Ft. Year Year	% of Change
July							
August							
September							
October							
November							
December							
January							
February							
March							
April							
May							
June							
Total for Year							

APPENDIX B—
OPERATIONS AND MAINTENANCE AUDIT

OPERATIONS AND MAINTENANCE AUDIT
This checklist is to be used on the walk-through of each building. It is intended to identify the condition and mode of operation of the facility.

SCHOOL DISTRICT: ______________________________

BUILDING NAME: ______________________________

BUILDING ADDRESS: ______________________________

____

BUILDING SQ FT: ______________ DATE OF AUDIT: ________

AUDIT PERSONS AND TITLES: ______________________

____

____

ENERGY CONSUMPTION:

Fiscal Year	Natural Gas (Ft^3)	Oil (Gal)	Electricity (KWH)

BTU/FT^2/Yr: HEATING ______________ ELECTRICITY ______________

BUILDING OCCUPANCY SCHEDULE:

Now Last Audit % Change

1. Hours per day ______________________________
2. Evening Hrs ______________________________
3. Weekend Hrs ______________________________
4. Summer Session ______________________________

STRUCTURAL

BUILDING ENVELOPE (EXTERIOR):

1. General condition: Good________Fair________Poor________
2. Structural Cracks: Yes________ No__________
3. Expansion Joint Condition: Good______ Fair______ Poor_____
4. Additional Building Envelope Comments:______________________

____

____

ROOF:

1. Condition: Good______ Fair______ Poor_______
2. Leaks: Yes________ No________
3. Pitch Pockets: Yes________ No__________

   Condition: Good______ Fair_______ Poor________
4. Skylights: How Many_____ Insulated: Yes___ No___
5. Blisters: Yes______ No_______

Above____

Above____

Above____

6. Expansion Joints: Yes_______ No_______

   Condition: Good_______ Fair_______ Poor_______
7. Roof Drains: Clean______ Dirty_______ Functional_________
8. Flashings: Condition: Good________ Fair_______ Poor_______

Location: Problem:

____

____

____

9. Bare Felts: Yes________ No_________
10. Debris on Roof: Yes_______ No_______

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11. Additional Roof Comments:____

____

____

EXTERIOR DOORS:

1. Wood Good______ Fair_____ Poor_______

   Steel Good______ Fair_____ Poor_______

   Aluminum Good______ Fair_____ Poor_______

   Other Good______ Fair_____ Poor_______

2. Vestibule Doors: Yes______ No______ Used: Yes_____ No_____

3. Closure Operation: Good______ Fair_____ Poor_______

4. Weatherstripping: Good_____ Fair____ Poor_____None_____

5. Threshold Condition: Good______ Fair_____ Poor_______

   Needs Replacement__________________________

6. Doorsweep: Good______ Fair_____ Poor_______ Needs Replacement__________________

WINDOWS:

1. Glass: Single______ Double______ Triple_______ Storms: Yes______ No______

2. Frame: Wood______ Steel______ Aluminum______ Other_______

   Condition: Good______ Fair_____ Poor_______

3. Window Type: Fixed_______ Awning_______ Double______ Hung______ Other______

4. Window Fit: Tight____ Loose____ Needs Adjustment_______

5. Weatherstripping: Good____ Fair____ Poor____ None____

6. Glazing: Good______ Fair_____ Poor_______

7. Caulking: Good______ Fair_____ Poor_______

8. Shading: Awnings______ Blinds______ Shades______ Screens_____
   Curtains________ Drapes________ Other_________

Additional Window Comments:____

____

____

O & M AUDIT
HVAC SYSTEM & CONTROLS BOILER DATA

	Boiler #1	Boiler #2	Boiler #3
Age of Boiler			
Type of Fuel			
Turbulators (yes or no)			
Combustion Air Opening (Clean or dry)			
Flue Gas Analysis Date			
Efficiency (%)			
Stack Temperature			
Steam Pressure On Off			
Water On Off			
Water Treatment (yes or no)			
Low Water Cutoff Test (yes or no)			
Safety Relief Valve Test (yes or no)			

Boiler Controls	Yes	No	Functional	Yes	No	Functional	Yes	No	Functional
Outside Air Temp Reset									
Outside Air Shutoff									
Three Way Valve									

Boiler & Pipe Insulation: Good____ Fair____ Poor____ None_____

Steam Traps: Yes_______ No_________

Trap Rebuild Program: Yes_______ No_______

How often rebuilt?___________________________________

STEAM TO HOT WATER CONVERTERS:

a. Heating: Yes_____ No______ Functional: Yes______ No______

b. Domestic: Yes_____ No_______ Functional: Yes______ No_______

c. Pool: Yes_____ No_______ Functional: Yes______ No_______

O & M AUDIT
HVAC SYSTEM & CONTROLS

H.W. Heating Pumps

No. of Pumps	Location	Type of Control			Functional		Hours of Operation
		Manual	Zone Thermostat	Outside Air Temp	Yes	No	

Additional Comments:

O & M AUDIT
HVAC SYSTEM AND CONTROLS

PNEUMATIC CONTROL SYSTEM:

1. Air Compressor:

Pressure Settings: On_______ psi, Off________ psi

Minutes On/Off: _______________/______________

Drain Valve: Yes______ No_____ Manual______ Automatic_______

Air Intake: Inside_____ Outside____ Clean______ Dirty_____

Summer Operation: Yes_______ No_______

Level of Maintenance: Good_____ Fair_______ Poor______

Air Leaks: Yes_______ No_______

2. Night Setback System: Yes___ No___ Functional: Yes___ No___

Degree setting for night: ___________ Day:__________

Are clocks at correct time setting: Yes________ No________

Additional Comments:

3. Room Thermostats:

Calibrated: Yes_______ No________ Frequency_________

Temperature setting:_______________________________________

Locked: Yes_______ No______

O & M AUDIT
HVAC SYSTEM & CONTROLS

HVAC System Control

Type	Outside Air		Type of Control				Function		Hours of Operation
	100%	Min Position %	Manual	Night Setback	Time Clock	Central Control	Yes	No	
Unit Ventilator									
Central Fan Coil									
Multizone									
Unit Heater									
Radiation									

O & M AUDIT
HVAC SYSTEM & CONTROLS

EXHAUST FANS

Type	Type of Control					No. of Fans	Damper Condition		Hours of Operation	Days of Operation	Dirty	
	Manual	Light Switch	Time Clock	Twist Timer	Central Control		Tight Shutoff					
							Yes	No			Yes	No
Toilet												
Kitchen												
General												
Gym												
Shops												
Pool												
Lab												
Dishwasher												

O & M AUDIT
HVAC SYSTEM & CONTROLS

AIR CONDITIONING UNITS

Type	Condenser		Type of Control				Discharge Air Temp		Area Served	Winterized	
	Air Cooled	Water Cooled	Manual	Time Clock	Water Temp	O.A Lockout				Yes	No

O & M AUDIT

DOMESTIC HOT WATER

Heater	Location	Type			Water Temp	Type of Control		Pump Control		
Number		Gas	Oil	Elec		Aquastat	Time Clock	Manual	Time Clock	Return Temp

1. Pipe Insulation: Good______ Fair______ Poor________ None_________

2. Leaks: Yes________ No_________

3. Shower Control:

   a: Reduced Flow Heads: Yes_________ No_________

   b: Shut Off Valves: Manual________ Automatic________

   c: Leaks: Yes_______ No________

4. Additional Water System Comments:

O&M AUDIT—KITCHEN

1. DISHWASHER:

Hot Water Temperature to Washer:________________________________

Temperature after Booster:________________________________

Type of Booster: Electric__________ Natural Gas-Fired__________

Booster Heater Control: Interlock with Master____________________

Manual____________ Other______________________________

Hours of Operation____

Comments:

2. PREHEATING:

Oven: Yes_______ No_______ How Long?______________________

Grill: Yes_______ No_______ How Long?______________________

Kettles: Yes_______ No________ How Long?______________________

Comments:

3. REFRIGERATORS:

Number:____________________

Temperature of Refrigerators:________________________________

Door Gasket Condition: Good______ Fair_______ Poor_______

Efficient Use: Yes____ No____ Percent Full________________

Condenser Type: Air Cooled_____ Water Cooled_____

Clean_____ Dirty_____

Water Regulating Valve Leaking? Yes__________ No__________

Comments:

0 & M AUDIT—KITCHEN (CONT'D)

4. FREEZERS:

Number:____________________

Temperature of Freezer:______________________________

Door Gasket Condition: Good________ Fair______ Poor________

Efficient Use: Yes_____ No_______ Percent Full_____________

Condenser Type: Air Cooled____________ Water Cooled__________

Clean__________ Dirty______________

Water Regulating Valve Leaking? Yes___ No___

Comments:

O & M AUDIT—LIGHTING

LIGHTING—BUILDING EXTERIOR:

1. Lighting Type: # of Lights

Fluorescent____________ Incandescent_____________

Mercury Vapor__________ Metal Halide___________

High Pressure Sodium____ Low Pressure Sodium____

2. Type of Control: Manual____ Time Clock____ Photocell____

Functional: Yes_________ No____________

3. Hours of Operation:____

____

____

LIGHTING—PARKING LOT LIGHTS:

1. Lighting Type: # of Lights

Mercury Vapor__________ Metal Halide________

High Pressure Sodium_________ Low Pressure Sodium_______

Other____

2. Type of Control: Manual____ Time Clock____ Photocell___

Functional: Yes__________ No____________

Comments:

3. Hours of Operation:____

____

____

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LIGHTING—INTERIOR:

1. Type of Control: Manual___ Time___ Clock___ Central___ Control____
2. Security Lights: Yes__________ No______________
3. Reminder Stickers: Yes___________ No____________
4. Task Lighting: Yes___________ No_________________
5. Light Cleaning Schedule: Yes_____ No_____ How Often?____________
6. Lamp Removal: Yes__________ No______________
   Percent removed:______________________
7. Paint Color: Light_____________ Dark_____________________
8. General Light Levels: High______ Low________ Adequate__________

Note Areas with High Light Levels:

METER READING

1. Who Reads Meters? Utility Company_____ In House______ Frequency______
2. Compare Reading with Utility Bills? Yes_________ No____________

MAINTENANCE

1. Who Maintains Equipment? Building Personnel___________________
   Contractor_________ Central Maintenance Personnel_____________
2. What Do Custodians Maintain?___________________________________
   ____
   ____

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APPENDIX C—TRANSPORTATION ENERGY CONSERVATION CHECKLIST

TRANSPORTATION ENERGY CONSERVATION CHECKLIST

Listed below are numerous ways transportation managers can conserve energy and reduce transportation costs.

A. **Transportation Policy**
   1. Coordinate school calendars and start and dismissal times between schools of each school system.
   2. Eliminate staggered dismissal times in the same building.
   3. Increase requirements for walking distances to school and to bus stops.
   4. Establish take-up and dismissal schedules at schools to support maximum vehicle utilization.
   5. Eliminate buses for detention students.
   6. Limit student parking, encourage high school pupils to ride school buses, form car pools, etc.
   7. Establish maximum distance for co-curricular trips (60 miles round trip).
   8. Utilize public mass transit, where feasible, to avoid duplication of service.
   9. Establish travel restrictions for school sponsored activities supporting athletic teams (cheerleaders, band, pep clubs, etc.).
   10. Eliminate buses for athletic team practices.

B. **School Bus Operation: Activity and Field Trips**
   1. Reduce, consolidate or eliminate all but the most necessary athletic contests, where feasible.
   2. Reduce, consolidate or eliminate all but the most necessary co-curricular trips, where feasible.
   3. Combine co-curricular and athletic trips for more than one school.
   4. Have districts share buses, when feasible.
   5. Establish minimum and maximum distances for all trips.
   6. Limit co-curricular trips to full bus loads only.
   7. Combine athletic schedules so several games can be played at the same location.
   8. Eliminate buses for transportation of students involved in after-school activities and for extra curricular activities for small groups.
   9. Contract with parents to provide transportation, when feasible.
   10. Utilize public transportation on return trips, where feasible.

C. **School Bus Operation: General**
   1. Lengthen distance between pick-up points.
   2. Establish collection points.
   3. Plan stops on level instead of on grades.
   4. Consolidate loads.
   5. Plan routes to make as many right-hand turns as possible to save on idling time, where safety permits.
   6. Use intercoms or video cameras on buses to reduce stops for controlling discipline.
   7. Use trip recorders to record and monitor driver and vehicle operation for speed control, where problems occur.
   8. Use smallest available vehicle for long distance, light-load turns.
   9. Install two-way radios to direct operation or redirection of buses to avoid unnecessary stops and route miles.
   10. Route buses to stay on main roads as much as possible.

D. **School Bus Routing and Scheduling**
   1. Fill buses to legal capacity.
   2. When replacing buses or expanding fleet, purchase buses with capacities to provide balanced fleet utilization.
   3. Utilize proven updating routing techniques, either by hand or computer, to maintain maximum vehicle utilization at all times.
      a. Evaluate current system.
      b. Revise system to reduce mileage, stops and student riding time and distance.
      c. Review policy and revise where needed.

4. Consolidate inter-district transportation, systems when possible, to meet special transportation demands.
5. Develop an alternate routing plan for implementation in emergencies and fuel shortages (weather, etc.).

E. **School Bus Operation: The Driver**

1. Retain experienced drivers as long as possible.
2. Train bus drivers in accepted practices geared to obtain maximum fuel economy.
3. Reduce warm-up time on buses to two minutes initially, and three minutes prior to starting routes.
4. Drive slowly the first few miles to warm up vehicle.
5. Avoid full throttle operation. Drive at steady speeds.
6. Avoid the "red line" especially in shifting gears.
7. Drive slowly back to bus garage. Turn corners slowly, drive next to center line on curves.
8. Reduce speed limit to as low as practical.
9. Avoid unauthorized courtesy stops.
10. Train new drivers on existing runs while bus is dead heading.
11. Use simulators to reduce behind-the-wheel training in vehicles.
12. Schedule sufficient number of driver inservice programs.
13. Hold joint workshops with drivers and mechanics to improve transportation operation.
14. Use driver incentive system for reducing vehicle fuel consumption.
15. Review driver times and routes. Determine most efficient vehicle utilization, layover and storage plan to minimize miles for school as well as personal vehicles.
16. Keep foot off accelerator when the bus is approaching a stop or is stopped and off brakes when in motion. Reduce braking by anticipating stops.

F. **School Bus Maintenance**

1. Tune and maintain engines, plugs, points and timing.
2. Maintain clean pollution controls.
3. Keep gas tanks full to avoid excessive evaporation.
4. Avoid fuel spillage when refueling buses. Do not "overfill." Do not fill to top of filler tube.
5. Replace buses that use excessive amounts of fuel as soon as economically feasible.
6. Keep fuel storage tanks locked; have one person in charge of fueling of buses and other school vehicles.
7. Keep accurate bus records for maintenance and fuel consumption.
8. Analyze cost data; make management decisions to maximize savings and efficiency.
9. Inventory all parts and supplies; order on a planned need basis; obtain best price; use base of past experiences (reduces "parts chasing").
10. In winter, if possible, keep all buses under cover rather than allowing drivers to take them home.
11. Use engine warmers for easier starts. Utilize automatic timers to minimize use of warmers.
12. Maintain clean oil and air filters.
13. Keep automatic choke clean. A sticking choke will waste fuel. Chemical cleaners save costly downtime.
14. Keep air-fuel mixture of carburetor precisely adjusted.
15. Regulate oil change with engine tune-up.
16. Use manufacturer's recommended weight of oil. If too heavy, the oil will force the engine to use more fuel; if too light, the oil will not provide the proper protection.
17. Check tire balance and wheel alignment to avoid "drag," which will use more fuel and shorten tire life.
18. Check radiator thermostat. A defective thermostat may prolong engine warm up, increasing fuel consumption.
19. Use proper octane rated fuel. Using wrong octane will result in plug foul up and reduction of mileage. Using a higher octane than required is a waste of money.
20. Use engine analyzing equipment to assure maximum efficiency.
21. Make full utilization of service manuals and maintenance bulletins to keep updated on maintenance techniques.
22. Take full advantage of free maintenance training clinics conducted by skilled instructors.

23. Keep brakes properly adjusted.
24. Repair engine oil leaks.
25. Install radiator shutters for retaining engine heat.
26. Install radial tires.
27. Retrofit with electronic ignition system.
28. Properly utilize proven fuel and oil additives.
29. Maintain proper tire pressure on a regular basis. Proper tire inflation is essential to fuel economy and tire wear.
30. Utilize new techniques such as rubber suspension systems, wheel balances, tire pressure equalizers and solid state ignition.

VEHICLE GASOLINE RECORD

Bus No.________________

Date	Mileage Reading	Gallons Gasoline	Quarts Oil	Name of Driver

MONTHLY
VEHICLE GASOLINE RECORD

Bus No.________________

Month____________________

Fill-Up Date	Odometer Reading	Gallons Fuel	Oil Qts.	Fill-Up MPG
1.				
2.				
3.				
4.				
5.				
6.				
Month Total				

A. Total Miles Driven = ____________________________

B. Total Gallons Fuel = ____________________________

C. Total Quarts of Oil = ____________________________

$$\text{Fuel Economy} = \frac{\text{Miles Driven}}{\text{Fuel (Gallons)}} = \frac{A}{B} = \_\_\_\_\text{MPG}$$

$$\text{Oil Economy} = \frac{\text{Miles Driven}}{\text{Oil Used}} = \frac{A}{C} = \_\_\_\_\text{MPG}$$

Average MPG Previous Month_________________________

Increase MPG__________________________

Decrease MPG__________________________

SAMPLE TRANSPORTATION POLICY

ADMINISTRATION REGULATION

BUSINESS AND NON-INSTRUCTIONAL OPERATIONS

ROUTES AND SERVICES

The following pupils resident in the school district and enrolled in grades kindergarten through twelve shall be eligible for transportation by school bus:

1. Any pupil enrolled in the public schools of this district who lives 2 miles or more for grades K-8 or 2½ or more for grades 9-12 from the school he/she attends. Measurement of distance shall occur from the intersection of the public street with the closest home driveway or walk to the intersection of the street with the closest school driveway or walk, along the most direct public route.
2. Any pupil enrolled in a non-public school who lives remote (as defined under #1 above) from the school he/she attends measured in the same manner except - that if he/she lives less than remote from the nearest public school offering an educational program at the grade level in which he/she is enrolled in the non-public school, he/she may be eligible for school bus transportation only between that public school and the non-public school he/she attends.

The following exceptions to the general eligibility rules shall apply:

1. All pupils enrolled in programs for handicapped children, designated and approved by the State Department of Education, shall be eligible for that additional transportation service necessary to permit them to attend the program as determined in their Individual Educational Programs.
2. Other exceptions to the general eligibility rules may be made according to regulations approved by the Board of Education.

The measurement of the mileage to determine eligibility for transportation shall be the responsibility of the Supervisor of Transportation. The supervisor's measurement shall be accepted as conclusive evidence of eligibility for transportation except that any person who feels himself aggrieved by this measurement may, at his own personal expense, employ a qualified engineer to make a more precise measurement for approval of transportation service for children living in his home who are legal residents of the school system.

REGULAR ROUTES AND SERVICES

In establishing bus schedules, it shall be the objective to arrange for buses to arrive at school approximately twenty minutes before the scheduled time for the beginning of classes in the morning and to leave within approximately twenty minutes after the scheduled dismissal time.

Each eligible pupil will be assigned to use a specific bus and bus stop, and shall not be permitted to use any other without permission.

The Supervisor of Transportation may grant permission for a pupil to ride a different bus or use a different stop. Such permission may be granted only upon receipt of a written request of principal, parent, guardian or other responsible adult for a specified period of time subject to administrative procedures.

PROCEDURES FOR EMERGENCIES SAFETY

For reasons of safety and efficiency, the number of stops on any one bus route shall be kept to a minimum. Whenever possible, bus stops will be arranged so that:

1. Elementary school pupils may be required to walk no more than 0.4 mile to the bus stop, junior high school pupils and high school pupils no more than 0.7 mile. Measurement shall exclude private property and shall be along the most direct and reasonable public route.
2. Exceptions to these walking distances may be made by the Board of Education. Recommendations for exceptions may be made when it has been determined that a condition exists that can be demonstrated to be an excessive or extraordinary hazard to the safety of children when compared with conditions typical to other pupils in the community.

3. The following guidelines will be used to move a stop, even when the stop meets the above guidelines:
   - A. The stop may be moved to another location (inside a subdivision or off a main road) when:
     - a. The number of students at a given stop is at or exceeds 20.
     - b. The volume of traffic is such that stopping the bus for a large number of students creates traffic problems. Assistance from the county road department, state highway department, sheriff's department, or state police post may be requested to establish volume of traffic.
     - c. Data shows that the stop-pickup is in a high accident location. Data from local law enforcement agencies will be used to verify that the stop is in a high accident location.
     - d. A stop may be moved inside a subdivision and off a main road when the bus needs a convenient turn around and the subdivision is the most logical place in which to make the turn around.
4. Routes are to be planned to keep individual student riding distance and time to a practical minimum.
5. Appeal Policy
   - A. When a request for change in a bus stop was not granted under the above guidelines through regular channels and procedures, a parent may ask that a requested stop be re viewed by the pupil transportation safety review committee. Such a request is to be in writing, stating the reason(s) for the requested change and specifically identifying where the stop is requested to be. The individual making the request should list the bus route, and give an address and telephone number where a contact can be made with the person making the request. The pupil transportation safety review committee will review the request and provide written reply within two weeks of the request.
   - B. If the requested change is not granted, the individual making the request may ask to appear in person before the safety review committee to appeal the decision. Such an appeal request will be made through the Transportation Supervisor.
   - C. If the requested change is not granted by the transportation review committee, the individual making the request may appeal to the Superintendent of Schools.
   - D. If a request has not been granted by the Superintendent of Schools, the request may be appealed to the Board of Education. The Transportation Supervisor shall be present at such appeals.

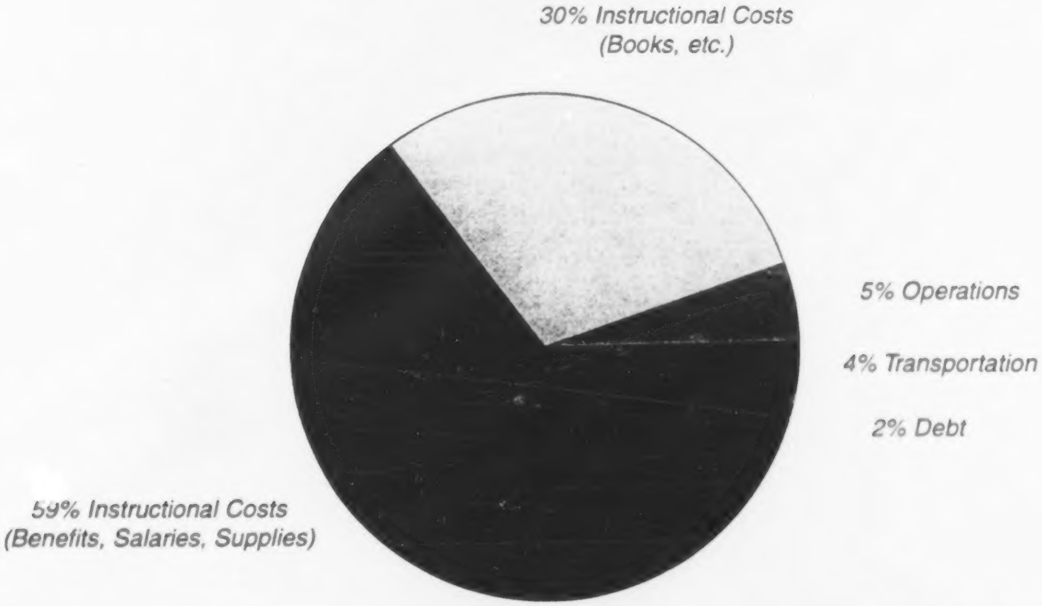
APPENDIX D—PERFORMANCE CONTRACTING

PERFORMANCE CONTRACTING

A PARADIGM SHIFT IN BUILDING RENOVATION PROCUREMENT

Imagine if you will, retrofitting your existing building's structure and systems, creating and/or expanding your preventative maintenance programs, funneling operations money to undertake "capital based" projects, initiating a staff training program, and have the "program's" financial and technical performance guaranteed in writing while paying for the entire program out of your existing operational budget!! These are the underlying concepts of the **performance contracting** process. The most accurate definition of **performance contracting** is: *A package of building and operational improvements that are self funded through the savings they produce and which are verifiable and guaranteed by the provider to perform as designed.*

Below is a representation of a typical school district budget and the associated funding allocation by department and/or sector. Although performance contracting only addresses issues within the operations manage-



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ment sector (5 percent of total), this is usually the only area of the district's budget that any real "adjustment" in funding utilization can occur.

It is this 5 percent that the school district can utilize in a more efficient manner to "self fund" projects that traditionally are considered only in a capital funded project. The operating budget is viewed as an asset rather than a liability. If a change in operational management does not occur the asset is "doomed" to be spent as it has in the past. Performance contracting is simply a redirection of these operational funds, through efficient methods and technology, to self funding the building retrofits **directly** from the operations budget.

The history of performance contracting goes back a number of years, when a few select companies created "energy services" based programs to assist their customers financially during the oil/energy crisis of the 1970s. These efforts were generally not well coordinated and typically were "custom" designed for each specific customer application. Programs such as "shared savings," "pay from savings," and "percentage payment" were the first of many ill-fated ventures during this developmental period. Then, in the late 1980s, a concentrated focus on the performance contracting was undertaken in earnest by industry leaders. Due to accelerating financial hardships, deteriorating buildings and operational infrastructures, and increasing public demand for financial accountability in the public school systems, the industry expanded and refined its programs to address the rapidly changing needs of its customers. With this expansion however, controls and legislation was needed to discourage abuses to the system but at the same time, encourage creative and logical processes to maximize the returns to the customer. States such as Ohio, Florida, Arizona, Michigan, Minnesota, and Texas all adopted legislation to provide a set of regulations for the performance contracting process. Through trial and error the performance contracting industry has developed this logical and workable "process" to ensure mutual understanding, agreement, and ultimately success in project development and execution. An overview of this process is as follows:

1. **Introduce the Concept**
   This initial step familiarizes all participants (i.e., superintendent, school business administrator, board, etc.) with all the issues and concepts of performance contracting. Any questions and concerns over logistics, legality, roles and responsibilities are uncovered at this time. A time line for each of the process steps is usually defined to ensure that all of the parties understand the order in which the steps will occur. Conceptual agreement is the goal of this phase where all participants agree the concept, in theory, would be workable and realistic.
2. **Preliminary Building Qualification**
   In this segment, the contractor will analyze utility and operational data as well as walk the district buildings to qualify each facility's potential based on historical/statistical norms. This "ballparking" estimate will be able to identify if the opportunity is "real" and usually can quantify the total value within a 10 percent margin of error.
3. **Administration Sponsor and Board Commitment**
   The data collected during the preliminary qualification is presented to the administration and the school board, which will then require the district to take one of two courses of action; (a) reject the recommendations and terminate the process or (b) agree that the initial findings have validated the initial concept and that further action should be taken. At this time that, contingent upon finalization of the engineering data and the financial details, the board will commit to a project upon a final presentation of the details. The board will authorize, at this time, the contractor to proceed with the detailed analysis and proposal sometimes with compensation identified for work performed.
4. **Detailed Study and Proposal**
   A detailed energy and operational study will be completed by the contractor to identify the opportunities, define the solution options, and to outline the financial considerations of each project component. Each of the components should be identified separately in regards to their cost, savings potential, and the financial details so the district can select only the options that fit their requirements.
5. **Board Approval and Contracts**
   This is the phase where all the information is organized into a workable proposal/ contract for the board to approve. This formal contract should include all the necessary terms and conditions required to form a legally binding contract. All the necessary agreements are finalized to allow the work to proceed. Also, at this time, any educational components and/or training issues will be identified and implemented into the final project scope.

6. **Implementation of Project**
   This "construction phase" includes all the physical improvements that have been agreed upon. Also, during this period, the ongoing service and guarantee monitoring arrangements are verified and finalized. Training and interaction with the school personnel begin at this point.
7. **Ongoing Service and Guarantee Management**
   This, the longest part of the relationship (up to ten years), involves the maintenance of the project's physical improvements as well as the monitoring and reporting of the financial "performance" of the project. Annual meetings are usually held to review the situation and to undertake financial and/or physical action to correct or enhance the current situation. Ongoing relationship management also continues to evolve where the contractor's personnel may continue to train the school staff and students on various concepts of energy management.

It is important to remember that performance contracting is not the same as the traditional method of bid and spec procurement where price is the sole determining factor. Legislation should be created to encourage **creativity, accountability,** and **value based** proposals based on a package of projects that is financially and operationally "correct" for the customer.

History has shown that if the vendors for these type of contracts are not able to address some basic issues, the customer, the contractor, and, indeed, the entire industry will suffer. Some of these "basic ingredients for success" are:

- Does the contractor have the financial ability to support what is promised for the entire term (often 10 years)?
- Does the contractor have the technical experience to provide a complete set of solutions to the customer?
- Does the contractor have a proven, logical process in which there are a set of checks and balances built in that will ensure all of the parties involved are comfortable with each step as they proceed?
- Is there a "verifiable" method of calculating the savings, and will the savings relate directly to the customer's bottom line?
- Is the contractor capable of identifying and implementing a wide range of facility improve-ments, or do they rely solely on their expertise in the energy related disciplines?
- Does the contractor develop the project scope with the customer as a "team" or is the proposal based on a non-negotiable, "take it or leave it" basis?
- What vendor service and support capabilities are available to ensure that the savings are maintained for the duration of the contract?
- What is the contractor's track record/resume for implementing projects of this type and magnitude?

To summarize, performance contracting may be the only method in the foreseeable future, of improving our schools physical infrastructure while maintaining the continuing trend of decreasing the budgetary commitment to operations and maintenance. When approached in a logical and organized fashion, performance contracting is a real opportunity which truly allows school districts to improve themselves and the learning environment, without the need for additional capital funding.

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